ARI Research Note 86-97

HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING: ANNUAL SUMMARY REPORT

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for

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This report presents a summary of the work performed by Anacapa Sciences, Inc. (ASI) for the Army Research Institute (ARI) Field Unit at Fort Rucker Alabama, under the contract "Human Factors Research in Aircrew Performance and Training". This research note contains summary descriptions of each of the projects on which ASI personnel worked during the third contract year -- September 1983 to August 1984. Each summary description contains: a background section that describes the rationale for the research and the research objectives; (over)

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a research approach section that describes the tasks and activities required to fulfill the project objectives; and a project status section that describes the work completed, the preliminary findings (if available), and the anticipated project completion date. Keywords:

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GLOSSARY OF ACRONYMS

AAA - Army Audit Agency
AAH - Advanced Attack Helicopter
AAMA - Army Aeromedical Activity
AAPART - Annual Aviator Proficiency and Readiness Test
ACE - Aviation Contractor Employees
AFTP - Additional Flight Training Period
AH - Attack Helicopter
AHIP - Army Helicopter Improvement Program
ANCOVA - Analysis of Covariance
ANOVA - Analysis of Variance
APS - Applied Psychological Services
AQC - Aviation Qualification Course
ARI - U.S. Army Research Institute
ARNG - Army National Guard
ARS - Ability Requirement Scale
ARTEP - Army Training and Evaluation Program
ASI - Anacapa Sciences, Inc.
AT - Annual Training
ATM - Aircrew Training Manual
AVRADCOM - Aviation Research and Development Command
AVSCOM - Aviation Systems Command
AWO - Aviation Warrant Officer
BES - Budgeted End Strength
BOIP - Basis of Issue Plan
CAV - Constant Angular Velocity
CG - Commanding General
CH - Cargo Helicopter
CO - Commissioned Officer
COI - Course of Instruction
CPG - Copilot/Gunner
CTEA - Cost and Training Effectiveness Analysis
DA - Department of the Army
DCD - Directorate of Combat Developments
DCSOPS - Deputy Chief of Staff for Operations
DCSPER - Deputy Chief of Staff for Personnel
DES - Directorate of Evaluation and Standardization
DMPM - Director of Military Personnel Management
DOAS - Department of Aviation Subjects
DOD - Department of Defense
DOFT - Directorate of Flight Training
FAAO - Field Artillery Aerial Observer
FAC - Flight Activity Category
FAR - Functional Arm Reach
FAST - Flight Aptitude Selection Test
FLIR - Forward-Looking Infrared
FORSCOM - Forces Command
FM - Field Manual
FS - Flight Simulator
FTTD - Full Time Training Duty

FY	- Fiscal Year
HEL	- Human Engineering Laboratory
HELLFIRE	- Helicopter Launched Fire and Forget Missile System
IERW	- Initial Entry Rotary Wing
IHADSS	- Integrated Helmet and Display Sight System
IMC	- Instrument Meteorological Conditions
IP	- Instructor Pilot
IPR	- In-Process Review
IRR	- Individual Ready Reserve
ITO	- Instrument Takeoff
LHX	- Light Helicopter Family
LL	- Leg Length
MEP	- Mission Equipment Package
MILPERCEN	- Military Personnel Center
MITAC	- Map Interpretation and Terrain Analysis Course
MLFA	- Maximum Likelihood Factor Analysis
MOI	- Method of Instruction
MOPP	- Mission Oriented Protective Posture
MOS	- Military Occupational Specialty
MSI	- Method of Successive Intervals
MTFE	- Maintenance Test Flight Evaluator
MTP	- Maintenance Test Pilot
MUTA	- Multiple Unit Training Assembly
NBC	- Nuclear, Biological, Chemical
NOE	- Nap of the Earth
NVG	- Night Vision Goggles
OAP	- Office of Accident Prevention
OH	- Observation Helicopter
PIC	- Pilot in Command
POC	- Point of Contact
POI	- Program of Instruction
PNVS	- Pilot Night Vision System
PPC	- Performance Planning Card
RACO	- Rear Area Consolidation Operation
RCPAC	- Reserve Component Personnel and Administrative Center
RFAST	- Revised Flight Aptitude Selection Test
RFP	- Request for Proposal
ROTC	- Reserve Officer Training Corps
SCAT	- Scout-Attack Team Trainer
SEAD	- Suppression of Enemy Air Defense
SFTS	- Synthetic Flight Training System
SH	- Sitting Height
SIP	- Standardization Instructor Pilot
SME	- Subject Matter Expert
TADS	- Target Acquisition and Detection System
TC	- Training Circular
TD	- Training Day
TEC	- Training Extension Course
TH	- Training Helicopter
THIESIS	- Training Helicopter Initial Entry Students in Simulators
TOT	- Transfer of Training

TRADOC	- Training and Doctrine Command
UH	- Utility Helicopter
USAALS	- U.S. Army Aviation Logistics School
USAARL	- U.S. Army Aeromedical Research Laboratory
USAAVNC	- U.S. Army Aviation Center
USMA	- U.S. Military Academy
UTA	- Unit Training Assembly
VMC	- Visual Meteorological Conditions
WOC	- Warrant Officer Candidate

INTRODUCTION

Anacapa Sciences, Inc. (ASI) is under contract to provide on-site research support to the Army Research Institute (ARI) Field Unit at Fort Rucker, Alabama. This contract (Contract No. MDA903-81-C-0504) commenced on 1 September 1981 and is scheduled to terminate on 31 August 1985. One of the contract requirements is to prepare a Yearly Summary Report that presents a brief description of each project that ASI personnel worked on during the contract year. This report, prepared to fulfill that requirement, describes the projects on which ASI personnel worked during the third contract year--1 September 1983 through 31 August 1984.

This report contains summary descriptions for each of the 16 projects on which ASI personnel worked during the third contract year. Most project summaries follow the same format. Each summary begins with a background section that presents the information an uninitiated reader needs to understand the requirement for the project. Also, if relevant, the background section describes the key events that led to the project's initiation. The background section is followed by a concise statement of the project objectives. When the need for the research cannot be inferred clearly from either the background or the objectives, the background section is followed by a statement of the need for the research.

The next section of the project summary, entitled "Research Approach," contains a moderately detailed description of what must be (or has been) done to accomplish the project objectives. For some projects, the research approach is an experiment in the strict sense of the word. For other projects, the research approach is a set of analytical or product-development tasks. In the research approach section, tasks and activities completed before the end of the contract year are described in the past tense; tasks and activities planned but not yet completed are described in the future tense.

The final section of the project summaries describes the status of the project and, if available, preliminary findings. An attempt was made to provide the reader with an indication of when the project work will be completed and when the project results will be documented in a preliminary or a final report. Readers who need information that is more current or more detailed than is presented in this report are invited to contact Mr. Charles A. Gainer, Chief, ARI Field Unit. His address and phone number are shown below.

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ASI personnel provided temporary support on other projects that were the primary responsibility of ARI personnel. Most notable among the temporary support tasks are: the organization of a conference on Army aircrew training (subsequently cancelled), a preliminary study of the relationship between aviator age and flight proficiency, and a review of the literature on the design and use of flight simulators. None of these three projects are reported herein.

It is important to point out that the projects summarized in this report represent only a portion of the projects presently under way at the ARI Fort Rucker Field Unit; ARI's research program also includes numerous projects that are the sole responsibility of ARI personnel.

The names and titles of members of ASI's Fort Rucker research team are listed below. Also listed are the ARI personnel who serve as the point of contact (POC) for one or more of the projects summarized herein. Every POC worked closely with ASI personnel and provided both technical direction and administrative support during all phases of the effort.

- o Dr. Kenneth D. Cross, Program Manager
- o Mr. Theodore B. Aldrich, Project Director
- o Mr. Walker Craddock, Operations Research Analyst
- o Ms. Elinor F. Cunningham, Project Director
- o Dr. Dennis H. Jones, Project Director

- o Dr. George L. Kaempf, Project Director
- o Dr. Sandra S. Martin, Project Director
- o Mr. D. Michael McAnulty, Project Director
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- o Dr. Matilda J. Reeder, ARI POC
- o Dr. Michael G. Sanders, ARI POC
- o Dr. Brian D. Shipley, Jr., ARI POC
- o Dr. Robert H. Wright, ARI POC

AN ASSESSMENT OF THE EFFECTIVENESS OF TRAINING HELICOPTER INITIAL ENTRY STUDENTS IN SIMULATORS

Mr. Steven L. Millard, Project Director

BACKGROUND

Students entering the Army's IERW course learn their basic contact flying skills in the TH-55 aircraft--a small two-place helicopter the Army uses exclusively for training. After 50 hours of in-flight training in the TH-55, IERW students receive 125 hours of training in the UH-1H aircraft. To achieve instrument qualification, students must complete 40 hours of instruction in the UH-1 flight simulator. After becoming qualified in the UH-1 aircraft, students may join an operational unit as a UH-1 aviator or enter qualification training in another aircraft type.

There is a clear and pressing need to consider alternatives to training basic flight skills in the TH-55 helicopter. The reasons for this need are explained below.

Cost/Availability of Training Aircraft

The TH-55 is the only helicopter in the Army's inventory that requires high octane aviation fuel. In the event of a major fuel shortage, high octane fuel could become costly enough or scarce enough to disrupt the Army's IERW training program. Furthermore, maintaining a separate fleet of aviation fuel trucks and an aviation fuel contract is burdensome and expensive.

A more important concern is the impending end of the useful life of the TH-55. At present, no new TH-55 aircraft are being acquired to replace those in the aging fleet. A phase-out of the TH-55 would require the Army to select from among three options: the acquisition of a new training aircraft to replace the TH-55, the conduct of primary flight training in an aircraft that is now in the Army inventory, or training helicopter initial entry students in simulators (THIESIS).

It seems unlikely that a decision will be made to purchase a new training helicopter. The Department of Defense has resisted proposals to develop and produce aircraft that are to be used solely for training. Furthermore, the Army has a strong desire to channel all available resources into operational equipment (Roscoe, 1980).

The replacement of training in the TH-55 with training in an operational helicopter is not a promising option because most operational Army helicopters are far more costly and consume considerably more fuel than the TH-55 (Grice & Morresette, 1982). Based upon initial cost and fuel consumption alone, it appears that the OH-58 is the only helicopter in the Army inventory that is even marginally suitable for use in conducting primary training.

There are no data available for use in evaluating the feasibility of replacing training in the TH-55 with training in a flight simulator; the research reported here has been designed to provide the data needed to assess this option.

Availability of Other Training Resources

Because of limited training resources at Fort Rucker, the Army is unable to accommodate a large and sudden surge in the training load. During the mobilization of Army aviation for the Vietnam War, IERW graduates exceeded 5,000 per year. During this period, primary training in the TH-55 was conducted at Fort Wolters, Texas; only the advanced phases of IERW were conducted at Fort Rucker. When the Army phased down pilot training, all IERW training was consolidated at Fort Rucker, and the number of IERW graduates was reduced to fewer than 1,000 per year. The current IERW training load--about 2,000 students per year--severely taxes the usable airspace and physical facilities at the USAAVNC. In the event of another major mobilization, USAAVNC would be hard pressed to increase the number of graduates to that of the Vietnam era without exceeding the capacity of existing airspace, stagefields, and other physical facilities at Fort Rucker. The reactivation of Fort Wolters is a feasible option, but a very costly one. It is possible that a more

cost-effective option is to increase the training capability of Fort Rucker by increasing the amount of training that is conducted in flight simulators.

PROJECT OBJECTIVES

The specific technical objective of this research is to assess the extent to which contact flight training in a simulator equipped with an external visual system transfers to a UH-1H aircraft for initial entry flight students. A factor complicating the accomplishment of this objective is the absence of a UH1FS equipped with a visual system. The lack of a UH1FS with a visual system necessitates the use of a simulator for a different aircraft--the AH1FS, the CH47FS, or the UH60FS. Therefore, a secondary objective of this project is to identify the existing simulator that is the best surrogate for a UH1FS with a visual system.

RESEARCH APPROACH

Overview

A group of ten student aviators were trained on basic flight tasks in the AH-1 flight simulator (experimental group). A matched group of ten student aviators received conventional training in the TH-55 aircraft (control group). Then, members of both the experimental group and the control group progressed through the same training sequence throughout IERW training in the UH-1 aircraft. Data on academic grades, flight grades, flight hours, and setbacks were recorded for both groups throughout training. In addition, questionnaire data were collected from both students and IPs at critical points throughout training.

Selection of a Flight Simulator

As was stated above, there are no UH1FSs with visual systems in the Army inventory, so it was necessary to select from among the available FSs with visual systems--the CH47FS, the UH60FS, and the AH1FS--the one most similar to the UH-1. The AH1FS was clearly the best option. The AH-1 and UH-1, manufactured by the same company, are both single-

engine, single-rotor, two-bladed, skid-type aircraft. Moreover, the AH-1 instrumentation is nearly identical to the instrumentation in the UH-1H. Although the airframe and flight characteristics of the two aircraft differ considerably, the magnitude of the differences in the FS can be (and were) reduced considerably by adjusting selected parameters in the AH1FS equations of motion.

Subjects

A total of 10 experimental-group subjects were selected from an IERW class. Experimental-group subjects were selected randomly from class members who had no prior flight instruction. Once the experimental-group subjects were selected, a matched sample of 10 control-group subjects were selected from the same class. Factors used in selecting a control-group counterpart for each experimental-group subject include: RFAST score, age, sex, source of commission, and prior flight instruction (none). To avoid an impact on the appointment and date of rank of WOCs, all subjects selected for this research were commissioned officers.

Method

The 10 control-group subjects received conventional primary training in the TH-55 aircraft (eight weeks, 50 TH-55 hours); the 10 experimental-group subjects received all their primary training in the AH1FS (eight weeks, 40 AH1FS hours). Both groups were trained by Aviation Contractor Employees (ACE) IPs--civilian IPs who administer primary training to all IERW trainees. Both groups of subjects received classroom instruction of the type currently administered during the primary phase of IERW training except that the aircraft-specific classroom instruction administered to the experimental-group subjects dealt only with the UH-1H aircraft. At the completion of primary training, the 20 subjects received the same sequence of instruction in the UH-1 aircraft throughout the remaining phases of IERW instruction: UH-1 transition training, basic and advanced instruments training, night and NVG training, and combat skills training.

Since these students were a part of an experimental program, a special setback/elimination policy was adopted. In essence, the policy dictates that no experimental-group subject could be eliminated from training during the UH-1 transition phase. Should a student's performance indicate a lack of proficiency usually associated with elimination, the student would be returned to the primary phase of training and progress through a normal IERW training cycle.

Data Collection

Comprehensive data files were maintained on all students, experimental and control, from the onset to the termination of IERW training. The types of data compiled included: academic grades, daily flight grades, checkride scores, flight hours to solo, flight hours to complete each training phase, number completing the training phase on time, number of setbacks, and number of eliminations. In addition, data were compiled from questionnaires designed to assess students' and IPs' opinions about the relative strengths and weaknesses of the simulator trained students.

PRELIMINARY RESULTS

Only two students failed to complete the IERW training program satisfactorily. One member of the experimental group voluntarily withdrew from the program, and one member of the control group was involuntarily removed from the program because of lack of progress. Overall, the data show that receiving primary training in the AH1FS did not significantly handicap members of the experimental group during the remaining stages of IERW training. Descriptive data for the experimental and control group are presented in the following table entitled "Summary of Student Progress by Phase."

SUMMARY OF STUDENT PROGRESS BY PHASE

PHASE	PROGRESS CRITERION	SIMULATOR STUDENTS	MATCHED CONTROLS
PRIMARY	BEGAN TRAINING	N = 10	N = 10
	SETBACk	0	0
	COMPLETED PHASE ON TIME	10	10
	PROGRESS EVALUATION FLIGHTS	1	0
	MEAN FLIGHT HOURS TO FIRST SOLO	15.5	14.5
	MEAN ACADEMIC GRADE	91.1	91.6
	MEAN FLIGHT GRADE	87.7	86.6
UH-1 TRANSITION	BEGAN TRAINING	N = 10	N = 10
	SETBACK	3	1
	COMPLETED PHASE ON TIME	6	9
	ELIMINATION	1	0
	TRAINING ACCIDENT	0	1
	MEAN FLIGHT HOURS TO SOLO UH-1	10.6	8.1
	MEAN ACADEMIC GRADE	96.8	96.2
	MEAN FLIGHT GRADE	81.5	84.9
BASIC INSTRUMENTS	BEGAN TRAINING	N = 9	N = 10
	SETBACK	0	0
	COMPLETED PHASE ON TIME	9	9
	MEAN ACADEMIC GRADE	91.7	94.5
	MEAN FLIGHT GRADE	86.9	88.5
ADVANCED INSTRUMENTS	BEGAN TRAINING	N = 9	N = 10
	SETBACK	1	0
	COMPLETED PHASE ON TIME	8	10
	MEAN ACADEMIC GRADE	88.8	91.9
	MEAN FLIGHT GRADE	85.3	83.5
COMBAT SKILLS I	BEGAN TRAINING	N = 9	N = 10
	SETBACK	0	0
	COMPLETED PHASE ON TIME	9	10
	MEAN ACADEMIC GRADE	92.6	94.6
	MEAN FLIGHT GRADE	83.8	85.0
NIGHT/NVG	BEGAN TRAINING	N = 9	N = 10
	SETBACK	0	0
	COMPLETED PHASE ON TIME	9	10
	MEAN ACADEMIC GRADE	96.1	94.3
	MEAN FLIGHT GRADE	87.1	87.0
COMBAT SKILLS II	BEGAN TRAINING	N = 9	N = 10
	SETBACK	0	0
	COMPLETED PHASE ON TIME	9	10
	MEAN ACADEMIC GRADE	92.2	94.6
	MEAN FLIGHT GRADE	87.3	87.5

PROJECT STATUS

All training and data collection had been completed by 12 August 1984. At that time, ARI personnel assumed responsibility for the remaining work on the project, including data entry, data analysis, and report preparation.

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VALIDATION OF AIRCREW TRAINING MANUAL REQUIREMENTS

Dr. John W. Ruffner, Project Director

BACKGROUND

With the passage of the Aviation Career Incentive Act of 1974, Congress and the General Accounting Office imposed on all military services a requirement to "justify" their flying-hour programs in order to receive continued funding. In June 1976, the Comptroller General of the United States reviewed the flying-hour programs of the military services and criticized the Army's inability to justify its program. The other services were able to show how flight hours were being used, but the Army was unable to satisfactorily document the use and benefits of the 80 flying hours allotted annually for each aviator.

As a result of the Comptroller General's report, the Vice Chief of Staff of the Army directed that a task force be formed to develop a program that specifies, for each type of aircraft, how the flight hours allocated annually should be used to maintain individual proficiency and combat readiness. A task force from the Army Training and Doctrine Command (TRADOC) was created in 1976 to develop the Aircrew Training Manual (ATM) program (Lovejoy & Presley, 1980).

An ATM was developed for each operational aircraft in the Army inventory. The ATM for each aircraft lists (a) the individual flying tasks that must be satisfactorily performed during qualification training, mission training, and refresher training; (b) the flight hours and academic hours allotted to specific subject areas within each type of training; and (c) the standards for the satisfactory performance of each flight task. In addition, the ATM specifies the minimum number of times each ATM task should be performed (i.e., practice iterations) and the minimum number of hours that should be flown by mission-ready aviators during each six-month period of continuation training. The purpose of continuation training is to maintain aviator currency and individual proficiency in an aircraft.

The minimum number of iterations and flight hours required to fulfill the ATM continuation training requirements depends on the Flight Activity Category (FAC) selected for the aviator by the unit commander. Aviators who are placed in FAC 2 positions need only fly the number of iterations and flight hours required to maintain proficiency in basic flight tasks. Aviators placed in FAC 1 positions must be capable of performing combat, combat support, or combat service support missions. Hence, FAC 1 aviators must maintain proficiency in both (a) basic flight tasks and (b) the tactical tasks appropriate for the type of aircraft flown (e.g., utility) and the mission of the unit to which the aviator is assigned (e.g., troop support).

Unit commanders are responsible for establishing a training-task list for each FAC 1 and FAC 2 position (Department of the Army, 1980). Ordinarily, the unit commander's training-task lists correspond closely with the task lists presented in the ATMs. However, training tasks may be added to or deleted from the ATM task lists if the commander judges that such additions/deletions will enhance the aviators' combat readiness.

NEED

The ATM iteration and flying-hour requirements were subjectively estimated by the subject matter experts (SMEs) who served on the TRADOC task force. The number of iterations for each task and the number of flying hours specified in the ATMs represent the SMEs' best estimate of the minimum necessary to maintain individual flight proficiency over a six-month period of continuation training. However, until now, no attempt has been made to confirm empirically the SMEs' subjective estimates. Since the cost of flying hours continues to increase, a need exists to determine empirically the minimum number of ATM task iterations and the minimum number of flying hours required to maintain individual flight proficiency. Empirical data on the iteration and flight-hour requirements are needed to help Army decision-makers determine the most effective ways to use the limited number of flying hours available to them.

In 1980, ARI was tasked by the Aviation Center Directorate of Evaluation and Standardization (DES) to validate the semiannual ATM task-iteration requirements for continuation training.

PROJECT OBJECTIVES

The ATM Requirements Validation research has three specific objectives:

- to determine whether or not the minimum number of semiannual task iterations specified in the ATMs are appropriate for the maintenance of individual aviator proficiency on FAC 2 tasks,
- to identify the tasks for which changes in the iteration requirements are needed to achieve training effectiveness, and
- to determine if the number of iterations required to maintain proficiency depends on the total number of flight hours an aviator has logged during his career.

RESEARCH APPROACH

Because of time and resource constraints, the scope of the ATM Requirements Validation project was limited to the investigation of semiannual task iteration requirements for a FAC 2 continuation training program. Iteration requirements for FAC 2 aviators apply directly to FAC 1 aviators, who also must maintain proficiency in FAC 2 tasks.

A field experiment conducted at USAAVNC, Fort Rucker, was designed to meet the project objectives. A total of 79 staff aviators assigned to FAC 2 positions served as subjects in the experiment. Staff aviators were selected as subjects because they do not fly as a regular part of their duty assignments, but are required to meet ATM semiannual task iteration and flying hour requirements.

The subjects were assigned to one of four groups--a control group and three experimental groups--such that the mean number of rotary wing flight hours logged prior to the outset of the study was approximately the same for each group. At the beginning of the six-month period, subjects were given initial checkrides by USAAVNC Standardization Instructor Pilots (SIPs) to establish their baseline level of performance.

Subjects assigned to the control group were prohibited from all flying during the six-month period following the initial checkride. Subjects assigned to the three experimental groups were required to complete either two, four, or six practice iterations of 47 FAC 2 contact and terrain flight tasks during the six-month period. All practice iterations were performed in the UH-1 helicopter. The UH-1 is the aircraft used by the majority of FAC 2 aviators to maintain proficiency. Fourteen of the tasks were procedural tasks; 33 were psychomotor tasks.

Half the subjects assigned to an experimental group were scheduled to fly during the first three months of the test period; the other half were scheduled to fly during the second three months. Staff IPs supervised and graded performance on all practice flights.

At the end of the six-month period, each subject was given a final checkride by an SIP to measure level of performance on each of the tasks. Performance data were collected during both checkrides and practice flights. Practice flight data were retained for later analysis.

In addition to flight performance data, data were collected on the aviators' confidence in their ability to perform each task. Aviators rated their confidence to perform each task to ATM standards both before and after the initial and the final checkride. Confidence data were analyzed to determine the relationship between confidence level and checkride scores at the beginning and at the end of the test period.

PROJECT STATUS

Work Completed

All data have been collected and analyzed. The data analysis procedures and results are summarized in the following paragraphs.

For the purpose of data analysis, subjects were divided into two flight-hour groups of approximately equal size: (a) those with less than 900 total rotary wing flight hours, and (b) those with more than

900 hours. Analysis of initial checkride scores indicated that there were no significant performance differences among the control and experimental groups prior to the six-month test period.

Performance data were analyzed in an analysis of variance using checkride scores as the dependent variable. The number of iterations and flight hour groups were treated as between-subjects independent variables; tasks and checkrides (initial and final) were treated as within-subject independent variables.

The results show that there is no significant difference between average pretest and posttest performance scores for either control-group or experimental-group subjects. In other words, the performance of the control-group subjects (no practice) did not degrade significantly during the six-month period; nor did the performance of experimental-group subjects improve as a result of the practice iterations they received. This finding is true regardless of the number of total rotary wing flight hours logged and whether the tasks are psychomotor or procedural. The data suggest that, during a six-month training period, proficiency on the 47 contact and terrain flight tasks evaluated does not degrade appreciably even with no practice whatsoever. The results are consistent with previous research on the retention of psychomotor flight skills (e.g., Mengelkoch, Adams, and Gainer, 1960; Prophet, 1976).

Factor analysis of the final checkride performance data suggests that there are six independent sets of tasks that underlie overall checkride performance. The descriptive labels for the task sets are listed below:

- emergency tasks,
- terrain flight tasks,
- hovering tasks,
- high-angle approach tasks
- procedural tasks, and
- basic airwork tasks.

Overall performance can be estimated reliably using as few as ten tasks sampled from the six task groups.

Overall checkride performance at the end of a six-month period is not reliably predicted by (a) the number of hours flown by the subjects during the last six or 12 months, (b) initial checkride scores, (c) the length of the no-practice period, or (d) aviators' self-rated confidence. In short, the results of this research do not support the requirement for aviators to perform the current minimum number of ATM FAC 2 contact and terrain flight task iterations over a six-month continuation-training period. However, sufficient data are not available to generalize the results to (a) training periods longer than six months, or (b) instrument tasks, emergency tasks, night tasks, or mission-specific tasks.

At the beginning of the third contract year, the draft final report for the ATM Requirements Validation project was reviewed by ARI; the draft report was revised based on comments by the ARI reviewers. The final report, entitled "Validation of Aircrew Training Manual Practice Iteration Requirements" was submitted to ARI as a contract deliverable on 2 November 1983. Dr. Ruffner presented a technical paper based on the results of the research at the 27th Annual Meeting of the Human Factors Society on 11 October 1983. The paper was entitled "Factors Affecting Flight Skill Retention of Active Duty Army Helicopter Pilots."

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REVISION/VALIDATION OF THE INDIVIDUAL READY RESERVE AVIATOR PROGRAM OF INSTRUCTION: UH-1 AIRCRAFT

Mr. Daniel T. Wick, Project Director

BACKGROUND

It has been estimated that between 1.3 and 1.8 Army rotary wing aviators per cockpit seat would be required to sustain operations in any major conflict (Department of the Army, 1979). Currently, there is only one active duty aviator per aircraft seat in the Army inventory. This shortfall of Army aviators would be made even greater by a migration of officers from flying positions to staff positions during a major mobilization.

In 1978, the Department of the Army created the Individual Ready Reserve (IRR) Aviator Training Program as a means for eliminating the aviator shortfall that otherwise would exist during a major mobilization. The IRR Aviator Training Program is designed to fill the cockpit seats with individuals who once served successfully as Army aviators but subsequently chose not to remain on active duty. The fundamental premise underlying the IRR Aviator Training Program is that it is less costly to retrain former aviators and to maintain their flying skills through periodic refresher training than it is to train and to maintain a larger force of active duty aviators.

The Reserve Component Personnel and Administration Center (RCPAC) was given the responsibility for administering the IRR Aviator Training Program. This program differs from the Army Reserve and National Guard in that the IRR Aviator Training Program requires participation only during a single period each year, rather than the monthly participation required by the other reserve programs. As initially designed, the program required that an IRR aviator be assigned to a specific field unit and that he report to his assigned unit for a 19-day training period once each year at the outset of the program. Each unit commander was made responsible for developing a program to train the IRR aviator assigned to his unit. This arrangement proved unsuitable because RCPAC

had no means of standardizing or evaluating the type and quality of training that the IRR aviator received at his assigned unit.

In 1979, the Deputy Chief of Staff for Operations (DCSOPS), in conjunction with Forces Command (FORSCOM) and RCPAC, requested the ARI Field Unit at Fort Rucker to develop a standardized IRR Aviator Training Program. The specific tasks that ARI was requested to accomplish are as follow:

- to evaluate the amount of deterioration in the flying skills of IRR aviators,
- to determine the amount and nature of training needed to correct this deficiency, and
- to develop a program for accomplishing the required training in a cost-effective manner.

ARI personnel commenced work on the assigned project by conducting a mail survey of (a) IRR aviators who had attended one or more on-site training periods, and (b) active duty personnel who had been directly involved in training one or more IRR aviators. The survey resulted in two clear-cut and important findings. First, it was found that the flying skills of the typical IRR aviator had deteriorated substantially during the period he had been away from active duty. Although the survey provided no precise measure of the amount and type of skill deterioration, the results clearly indicated that a significant amount of refresher training would be necessary to increase IRR aviators' flying skills to an acceptable level. Second, the survey results showed that the type and amount of training received by IRR aviators varied greatly from one installation to another. Training at some installations consisted of little more than self-study of military publications. At other installations, the entire training program consisted simply of passive rides in the copilot seat of a helicopter during routine mission-training exercises. Overall, there was an apparent lack of a standardized and systematic training program.

The survey results and information from SMEs were used by ARI personnel to develop a preliminary version of a Program of Instruction (POI) for the IRR Aviator Training Program (Allnutt & Everhart, 1980;

Everhart & Allnutt, 1981). The POI consisted of two training phases. Phase I consisted of training in basic flight maneuvers and in academic study of a wide range of topics. Phase II consisted of refresher training on Phase I maneuvers and academic topics, additional flight training in special and tactical maneuvers, and academic training in terrain analysis and map interpretation. All flight maneuvers trained in Phase I and Phase II were selected by FORSCOM.

The preliminary version of the POI was used to train a sample of 17 IRR aviators on Phase I maneuvers; the 19 days of training were conducted at Fort Rucker by experienced IPs. One year after the Phase I training period, six of the original 17 aviators returned to Fort Rucker for 19 days of Phase II training. The preliminary version of the POI proved to be generally effective, but the results revealed a number of ways in which the POI could be improved. The POI was revised in accordance with these findings.

Copies of the second version of the POI were distributed to field units along with a questionnaire designed to provide feedback on the POI's effectiveness. IPs were requested to use the POI and complete the questionnaire. An analysis of the questionnaire results revealed that two problems clearly compromised the effectiveness of the POI.

- Due to the lack of preparation by IRR aviators prior to their arrival at the unit, an unacceptably large portion of the 19-day training period was spent studying academic topics.
- An excessive amount of IP time was required to complete the academic instruction specified in the POI.

It was the need to eliminate these problems that led to the initiation of the present project.

PROJECT OBJECTIVES

This project was designed to address the problems revealed by the questionnaire results. The specific objectives of this project are as follows:

- to develop self-study materials that IRR aviators can use at home or at the unit training site to complete some or all of the academic preparation,
- to modify the academic portion of the POI to reduce the amount of IP time required to administer the training, and
- to evaluate the revised POI in a controlled environment.

RESEARCH APPROACH

The research plan for the project identified five general tasks that must be accomplished to fulfill the objectives of this project. These tasks are discussed below under separate headings. A description of both the task and the outcome is presented for the tasks that had been completed by the end of the contract year.

Definition of Academic Training Requirements

The purpose of this task is to define the academic topics that must be covered in the academic portion of the training program, and for each topic, to specify the specific knowledge that IRR aviators must possess in order to complete the course successfully. This task was accomplished by a team of SMEs composed of experienced IPs and experts in training technology.

The consensus of SME opinion was that the academic units for Phase I training should provide the student aviator the knowledge necessary to pass the pilot's oral examination as outlined in TC 1-135 (Department of the Army, 1980), the ATM for the UH-1 aircraft. It was also agreed that academic units for Phase II training would be limited to map interpretation and terrain analysis. The order, content, and number of academic units in the original POI were revised to cover more thoroughly the germane academic topics. The revised POI consists of 12 academic units for Phase I and five academic units for Phase II.

Development of Academic Training Materials

The original POI required 80 hours of IP lectures to cover the academic topics. The primary objective of this task is to develop a training approach and requisite materials that eliminate the requirement for IP involvement in academic training. An approach considered highly desirable is to provide IRR aviators with the opportunity to complete some academic study at home, prior to their arrival at the unit training site. Another desirable approach is to provide the IRR aviators with self-study materials that they can study at the training site during proctored study periods. Since the amount of time IRR aviators will devote to home study is uncertain, a combination of the two training approaches is employed; that is, each IRR aviator will be provided an opportunity to engage in home study and an incentive for doing so. However, because the amount of home study cannot be controlled, the program must be designed such that all or any part of the academic training can be accomplished through self-study at the unit training site.

Another factor considered in developing academic training materials is that individual IRR aviators can be expected to differ greatly in their need for academic training. Individual differences in the need for academic training stem from differences in the amount of flight time logged by the aviators, differences in the time that has transpired since the aviators have flown regularly, and differences in the aviators' fundamental abilities. Hence, it is essential that academic training materials be developed that enable individual aviators to (a) study only the topics on which their knowledge is deficient, and (b) proceed through the training as swiftly as their capabilities permit.

Three types of materials were developed: a comprehensive set of reference materials, a detailed study guide, and a set of diagnostic examinations. The use of the materials is explained in the following description of the general training concept.

- Step One--The reference materials and study guide, consisting of 12 units, are sent to the IRR aviator's home about four weeks before he is scheduled to arrive at the training site. The IRR aviator is instructed that home study is not mandatory but that time spent on home study will increase the amount of on-site time that can be spent on inflight instruction. Aviators who choose to engage in home study are instructed to complete the work specified in the study guide.
- Step Two--The IRR aviator is required to complete a diagnostic (paper-and-pencil) examination as soon as he arrives at the training site. The examination contains 12 subtests covering 12 academic topics. A score of 90% or greater on any subtest excuses the IRR aviator from further study on the academic topic covered by the subtest.
- Step Three--An IRR aviator who fails to score at least 90% on any subtest is required to complete the self-study material specified for that topic in the study guide. Once the self-study has been completed, the IRR aviator is required to take a second examination on the topic. Any IRR aviator who fails to score at least 90% on the examination is directed to review the study material more thoroughly and is tested again on the same topic. Any IRR aviator who fails to score at least 90% on the third examination is provided one-on-one tutoring by an IP until the IP judges that the IRR aviator has sufficient knowledge about the topic. This procedure is repeated until self-study of all 12 academic topics has been completed.

Development of Inflight Training Plan

The goal in developing an inflight training plan is to enable IRR aviators to relearn flying skills as rapidly as is commensurate with safety. The flying tasks/maneuvers to be taught were specified by FORSCOM. The Phase I tasks/maneuvers include most of the tasks/maneuvers that must be mastered to qualify for FAC 2 positions. The FAC 2 positions are flying assignments in which an aviator must maintain basic flying skills. The main exception is that no training is provided on instrument flight tasks. In Phase II, IRR aviators are provided refresher training on all Phase I tasks/maneuvers and are trained on a set of tactical and special tasks.

Conduct On-Site Evaluation of POI

The objective of this task is to evaluate the POI's effectiveness when used to train a representative sample of IRR aviators under realistic training conditions. The research plan developed for this project stipulates that: (a) a total of 48 IRR aviators are to be trained at USAAVNC, Fort Rucker, Alabama; (b) each month for six consecutive months, a group of eight IRR aviators are to receive training on 19 consecutive days; (c) the last group of aviators are to complete training on 19 November 1982; and (d) the 48 IRR aviators are to return to USAAVNC for refresher training and Phase II training in 1983. Critical questions addressed by the evaluation are listed below.

- How much of the study guide will the average IRR aviator complete during home study?
- Are the study guide and reference material comprehensive in their coverage of academic topics?
- Are the study guide and reference material sufficiently clear and easy to use?
- How much time do aviators require to complete the self-study of each academic training unit?
- How many flying hours do IRR aviators require to relearn the requisite flying skills?

Revise the POI

The objective of the final task is to use the information from the evaluation to refine the POI. The revision of the Phase I POI was completed in July of 1983. The revision of the Phase II POI was completed in June of 1984.

PROJECT STATUS

Work Completed

First year aviator training. Forty-seven IRR aviators participated in training during the first year. Flight time for hands-on flight training averaged 21.0 hours per aviator. The aviators required approximately 20 hours of proctored self-study to complete academic training.

First year findings. The 47 aviators trained the first year varied widely in their demographic characteristics and flight experience. The age of the IRR aviators varied from 28 to 47 years, with a median age of 34 years. The flight time logged prior to the start of IRR training averaged 1622 hours, with a range of 235 to 5000 hours. The time that had transpired since the aviators left active Army service varied from one to 19 years, with a median of 7.5 years.

All aviators were able to pass the pilot's oral examination after completing the academic training portion of Phase I training. On the average, Phase I academic training required 9.8 days to complete, with a range of 5 to 18 days. Two demographic characteristics were related to the number of days required to complete Phase I academics. The number of hours required to complete Phase I academic training increased as a function of the number of years that had elapsed since the aviator left active Army service, and decreased as a function of the number of study guide units completed by the aviator prior to training. These two demographic characteristics were used in a mathematical equation that proved to be both statistically reliable and practically useful in predicting the days required to complete academic training. Total military flight experience was not related to the days required to complete academic training.

When given initial checkrides, the 47 aviators performed 14% of all tasks to ATM standards. On the average, 17 hours of flight training were required to relearn the flying skills needed to complete a Phase I checkride.

Two demographic characteristics were related to flight hours required to pass a Phase 1 checkride. The number of hours required to complete Phase I flight training increased as a function of the amount of time that had elapsed since the aviator had left active Army service, and decreased as a function of the aviator's total number of military flight hours. These two demographic characteristics were used in a second mathematical equation that proved to be both statistically reliable and practically useful in predicting the hours required to successfully pass a Phase I checkride.

Forty-five of the 47 aviators completed Phase II academics during the first training year. Twenty-four of the 47 aviators also successfully completed a Phase II checkride during the first 19-day training period. The average flight hours required to complete Phase II training was 4.3 hours, with a range of 1.0 to 9.1.

The findings indicate that approximately 94% of all IP time was spent in flight training or related activities, such as preflight and debriefings. Most of the remaining six percent of an IP's time was devoted to administrative paperwork.

Student assessment of the program reveals that the POI was acceptable to IRR aviator trainees. Ninety-eight percent of the students indicated that the POI was adequate or more than adequate as a training program for IRR aviators.

The results of the first training year demonstrate that the program has significantly reduced the requirements made on IP training and, at the same time, greatly increased the amount of training accomplished during the 19-day training program. Using the previous POI, many IRR aviators were unable to complete all of Phase I training during the 19-day training period. In contrast, all of the aviators trained with the new POI were able to complete Phase I training, and one-half of them were able to complete both Phase I and Phase II training during the first 19-day training period.

In summary, it seems safe to conclude from the first year results that the revised POI is acceptable to IRR aviators and that the POI will result in a significant reduction in both the IP and IRR aviator time necessary to complete training.

Second year aviator training. All 47 IRR aviators were contacted four months prior to the commencement of the second year of training to determine if they could participate in the second-vear training. Twenty-four of the 47 aviators trained during the first year agreed to participate in the second year of training. Most of the remaining aviators were unable to attend due to civilian job conflicts or because they had joined reserve units. Time for hands-on flight training

averaged 20 hours per aviator. The aviators required an average of 20 hours of proctored self-study to complete the academic training.

Second year findings. The demographic characteristics of the 24 aviators trained during the second year were very similar to the demographic characteristics of the 47 aviators trained in the first year. The median age of the aviators was found to be 35 years, with a range of 29 to 44 years. The flight time logged prior to the start of the second 19-day training period averaged 1214 hours, with a range of 600 to 3100 hours. The time that had transpired since the last flying experience with the active Army varied from 2 to 12 years, with a median of 9 years.

When given initial checkrides after one year of no practice, the 24 aviators performed 45% of all tasks to ATM standards. An average of 14 hours of flight training was required to successfully complete a Phase I checkride. Twenty-two of the 24 aviators completed both Phase I and Phase II training; 15 of the 24 aviators completed both Phase I and Phase II training during the first year.

The findings of the second year suggest that proficiency in some flight skills is maintained throughout a one-year period of no flying. Also, there was an increase in the proportion of aviators who were able to complete both Phase I and Phase II training during a 19-day training period. However, the findings suggest that two 19-day training periods, separated by one year, is not enough time for some aviators to complete the training program.

In summary, the findings of the second year of training indicate that the revised POI continues to meet the goals of the IRR aviator training program while reducing the requirements for IP resources. Also, the findings contribute to the understanding of the factors that affect the retention of flight skills.

PROJECTED COMPLETION DATE

A first year report covering the first training period is currently being reviewed by ARI and will be completed on or about 31

October 1984. Work on the final report is under way. It is anticipated that the final report, having undergone formal review by ARI, will be completed on or before 31 December 1984.

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DEVELOPMENT OF A SEPARATION FORM FOR ARMY AVIATION WARRANT OFFICERS

Dr. Sandra S. Martin, Project Director

BACKGROUND

In October 1979, the U. S. Army Military Personnel Center (MILPERCEN), requested that ARI provide research support to investigate an apparent trend toward decreased retention of aviation warrant officers (AWOs). The request stemmed from retention data that indicated a significant decrease in the retention of first-term AWOs. These AWOs were leaving the Army at the end of the three-year obligation incurred by attending the Army's Initial Entry Rotary Wing (IERW) flight training program. This career point was the first opportunity for the AWOs to separate from the Army following the completion of flight training.[1]

Specifically, the data indicated that, for the AWOs who completed training in FY 1976 and FY 1977T[2] and who were eligible to leave the Army in FY 1979, retention beyond initial obligation was approximately 45%. In contrast, for the AWOs who completed flight training during the three previous years, the retention rate at the same career point had remained relatively constant at approximately 65% (Bills, 1979).

MILPERCEN was concerned that the increased rate of AWO attrition might signal the onset of an aviator retention problem that already was troubling the other military services. MILPERCEN also was concerned that a continued high rate of AWO separation might seriously reduce the Army's aviation readiness and combat effectiveness. The problem was exacerbated by the following additional considerations (Everhart & Sanders, 1981):

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[1] For those AWOs who began flight training after 30 September 1978, the initial obligation was extended to four years.

[2] Beginning in FY 1977, the fiscal year was changed from 1 July through 30 June to 1 October through 30 September. FY 1977T represents the period 1 July 1976 through 30 September 1976 during which the transition to the new fiscal year concept occurred.

- the increasing cost of aviator training and replacement,
- the increasing aviation force structure needs,
- the limitations in aviator training rates, and
- a decreasing manpower pool for the recruitment of aviators.

In response to MILPERCEN's request for research assistance, ARI conducted a worldwide survey of Army aviators. The survey used a questionnaire, constructed by ARI, to identify factors that contribute to attrition of AWOs. The questionnaire items were organized into two sections: a personal data section and a career factors section. Items in the personal data section were designed to provide information about the demographic characteristics, assignments, and career intentions of the respondents. Items in the career factors section were designed to determine the amount of influence that each of 46 factors have on AWOs' decisions to leave the Army.

During the four-month period from September to December 1980, approximately 900 AWOs and 300 commissioned officer aviators were surveyed. The AWOs were subsequently defined as retainees or attritees. The distinction was based on the AWOs' stated intentions to remain in or to leave the Army. Data provided by the survey identified demographic characteristics, such as age, rank, and Military Occupational Specialty (MOS), that are related to AWO attrition (Sundy, Ruffner, & Wick, 1981). In addition, the survey provided three different sources of information about the career factors that influence AWOs' decisions to leave the Army--self-reports of AWO attritees, peer perceptions of AWO retainees, and supervisory perceptions of commissioned officer aviators (Rogers & King, 1981).

The ten most influential factors identified by the AWO attritees reflect three major areas of concern: (a) pay and benefits, (b) leadership and supervision, and (c) career and assignment factors (Rogers & King, 1981). These areas subsequently became the focus of a series of initiatives that were developed by MILPERCEN to enhance retention of AWOs. Included in the initiatives was an overall increase in flight pay, as well as equalization of flight pay between warrant officer and commissioned officer aviators (Morgan & Johnson, 1981).

NEED/PROBLEM

Since the initiatives were enacted, retention of AWOs has steadily increased. Despite the increase, however, there are reasons for continuing concern about AWO retention. One of the primary reasons is the high training rate that is necessary to meet the Army's increasing aviation requirements. For example, in response to the AWO retention problem in FY 1979 and the projected increase in aviation force structure requirements, the Department of the Army (DA) directed the U. S. Army Aviation Center (USAAVNC) to increase the AWO training rate at Fort Rucker.

Due to the increase in both the training and retention rate for AWOs, the AWO inventory deficit experienced in FY 1979 has now become an overstrength problem. By the end of FY 1984, the Army is projected to have an excess of 460 AWOs relative to the Budgeted End Strength (BES). To reduce the overstrength, the Warrant Officer Division denied or revoked the VI career status of 60 AWOs whose initial obligation ended in FY 1984. In addition, DA has directed that 92 of the AWOs who were trained in FY 1981 be eliminated by the end of FY 1985 (Fulcher, 1984).

The perturbations in the AWO inventory relative to the Army's requirements reflect an inefficiency in the AWO personnel management system. The training increases that are necessary when the retention rate is low and the elimination of AWOs that is required when the retention rate is high are costly methods of maintaining an appropriate inventory. Currently, each aviator who leaves or is eliminated from the Army at the end of initial obligation represents a minimum training investment of $254,661. Clearly, a more efficient system of aviation force management is needed.

To facilitate the implementation of a more efficient AWO force management system, MILPERCEN tasked ARI to develop a separation questionnaire for AWOs. When the questionnaire becomes operational, it will be administered to all AWOs who leave the Army. Information provided by the questionnaire will be used to implement and maintain a continuous, closed-loop feedback system that will provide MILPERCEN with current

information about (a) the number and types of AWOs who separate from the Army, and (b) the type and importance of factors that influence AWOs' decisions to leave the Army. This information, in turn, can be used by the Department of the Army as an aid in activities such as:

- earlier detection of trends in the retention of AWOs;
- more specific interpretations of the trends in AWO retention;
- assessment of the impact that specific policies have on the retention of AWOs;
- more accurate projections of the AWO inventory for purposes of force planning and training;
- development of a retention program for controlling experience levels and training costs;
- development of proactive rather than retroactive retention measures; and
- development of more appropriate and less overreactive responses to retention.

Major users of the information include MILPERCEN, the Deputy Chief of Staff for Personnel (DCSPER), and the U. S. Army Aviation Center (USAAVNC).

PROJECT OBJECTIVES

The project has four specific research objectives. The objectives are to:

- identify the factors that historically have been related to military aviator retention,
- develop a preliminary version of the separation questionnaire,
- conduct pretests of the preliminary questionnaire and use the resulting information to develop the final version of the separation questionnaire, and
- develop and implement a data analysis plan for analyzing the data yielded by the separation questionnaire.

RESEARCH APPROACH

The initial step in developing the questionnaire is an extensive review of contemporary retention research. The primary purpose of the review is to determine the factors that historically have been related

to retention of military aviators. These factors help define the types of items the questionnaire must contain to yield the necessary data about AWO attrition. Two additional sources used to define the information requirements include (a) interviews of AWO attritees and subject matter experts (SMEs), and (b) reviews of existing Air Force and Navy separation questionnaires.

Specific items representative of each of the major categories of information requirements were written and compiled to form a preliminary version of the questionnaire. The four parts of the preliminary questionnaire are summarized as follows:

- Part I was designed to measure the demographic characteristics of AWOs.
- Part II was designed to measure the influence that each of 135 career factors has on the job satisfaction of AWOs.
- Part III was designed to measure the influence that each of 135 career factors has on the career decisions of AWOs.
- Part IV was designed to provide feedback about the suitability of the questionnaire's content and format.

Once the items to be included in the preliminary version of the questionnaire had been identified, two alternative forms of the questionnaire were developed. Form A was designed to be administered to AWOs who separate from the Army and to serve as the primary source of information about AWO attrition. Form R was designed to be administered to AWOs who remain in the Army to provide additional information about the factors that influence AWOs to remain in rather than leave the Army.

During FY 1984, the questionnaire was field tested at each of 17 major Army installations. Points of contact (POCs) at each installation administered the appropriate form of the questionnaire to AWOs who separated from the Army during FY 1984 and to a selected group of AWOs who chose to remain in the Army. The field test respondents were identified from computer printouts provided by MILPERCEN.

Due largely to the recent increase in the AWO retention rate, the projected number of AWOs who voluntarily left the Army during the field test period was significantly reduced. Consequently, the number of

questionnaires that were completed by AWO attritees provided an insufficient amount of data to perform statistical evaluations of the questionnaire. To preclude further delay in the implementation of the questionnaire, an alternative method of evaluation was adopted. The procedure consisted of an indepth review of the questionnaire by AWO subject matter experts (SMEs) at the Warrant Officer Division, MILPERCEN. Verbal feedback provided by the field test respondents and the SME reviewers was used to produce the final forms of the questionnaire.

PROJECT STATUS

The research project was completed in September 1984. The following products were submitted to ARI:

- a detailed Research Report entitled "Development of a Separation Questionnaire for Army Aviation Warrant Officers,"
- a condensed Summary Report entitled "Development of a Separation Questionnaire for Army Aviation Warrant Officers,"
- the final version of Form A entitled "Separation Questionnaire for AWO Attritees," and
- the final version of Form R entitled "Questionnaire for AWO Retainees."

The products were accompanied by a letter recommending that the Professional Development Division, Office of the Director of Military Personnel Management (DMPM), assume responsibility for implementing the questionnaire. The Professional Development Division is the agency within the Office of the Deputy Chief of Staff for Personnel (DCSPER) that is primarily responsible for monitoring the retention of all Army personnel (Weigand, 1984). The advantages of implementing the questionnaire through the Professional Development Division include (a) integration of the AWO separation questionnaire data with personnel information available from other sources, (b) continuity with the retention actions for enlisted personnel and commissioned officers, and (c) greater visibility of the AWO retention information at the DA level.

A recommendation also was made that the Professional Development Division consider implementing Form R of the questionnaire as a supplementary source of information about AWO retention. Form R can be administered to all AWOs at various points in their Army careers to provide longitudinal data about the retention of AWOs. The longitudinal data will facilitate the identification of critical factors that influence AWOs to remain in rather than leave the Army. The feedback also will facilitate the identification of critical points at which AWOs' career decisions are made.

Additional products that resulted from the research include the following:

- a Summary Report entitled "Aviation Warrant Officer Retention: A Summary of Past, Present, and Projected Research by the Army Research Institute" (Martin, 1982) that presents a comprehensive overview of ARI's research on AWO retention,
- a U. S. Army Aviation Digest article entitled "Aviation Warrant Officer Retention: A Continuing Effort" (Martin & Washer, 1983) that describes ARI's ongoing program of research on AWO retention, and
- a paper entitled "The Role of Retention in Managing the Aviation Warrant Officer Force" that was presented at the Ninth Psychology in DOD Symposium (Martin 1984a, 1984b) and subsequently was published in the Proceedings for the symposium.

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IDENTIFICATION OF PREREQUISITES AND SELECTION CRITERIA FOR AH-64 ADVANCED ATTACK HELICOPTER CREW MEMBERS

Mr. Theodore B. Aldrich, Project Director

BACKGROUND

Army aviators selected to fly the AH-64 attack helicopter will encounter a greater workload and a greater division of labor between the pilot and copilot/gunner (CPG) than they have encountered in any previous Army helicopter.

The CPG position features a target acquisition and detection system (TADS) composed of high technology components that include forward looking infrared (FLIR), a video day television viewing system, and direct view optics. A laser range finder and an airborne laser tracking and target cueing system will aid the CPG in reducing target acquisition time and in accomplishing the target acquisition functions under adverse visibility conditions. The TADS interfaces with a fire control system that enables the CPG to fire the Army's new HELLFIRE missile in several different modes. The AH-64 aircraft is equipped with a doppler navigation system that interfaces with the TADS and fire control computer. The operation of the doppler navigation system requires the CPG to perform a host of complex tasks. Finally, redundant controls are provided in the front crew station to enable the CPG to fly the aircraft when the mission or situation warrants (Hughes Helicopters, 1979).

The most striking example of the new technology in the pilot's crew station is the Pilot's Night Vision System (PNVS). The PNVS provides the visual information the pilot needs to fly the aircraft during darkness and under other adverse visibility conditions. The Integrated Helmet and Display Sight System (IHADSS) presents information to the pilot on a one-inch diameter, helmet-mounted cathode ray tube. This display, generated in part by the FLIR sensor mounted in the nose of the aircraft, provides flight instrument symbology superimposed on a thermal "real world" contact display. The flight instrument symbols provide information about heading, altitude, airspeed, engine power

management, attitude, and trim. The FLIR image on the IHADSS allows the pilot to stay "outside the cockpit" while flying under conditions of restricted or limited visibility. The AH-64 pilot has an exacting and demanding job flying nap-of-the-earth (NOE) in poor visibility conditions because the PNVS field-of-view is limited to 40 degrees. In addition to controlling the aircraft, the pilot must perform air-navigation tasks, weapon control and firing, emergency procedures, and must remain cognizant of the functions being performed by the CPG and the other combatants within the battle area (Hughes Helicopters, 1979).

Two tentative decisions have been made about the selection and training of AH-64 crew members. First, it has been decided that, initially, AH-64 trainees will be selected from the population of Army aviators who have demonstrated a high level of proficiency in the AH-1 aircraft (Hipp, 1978). The assumption underlying this decision is that highly proficient AH-1 aviators are likely to possess the abilities required to perform effectively in the AH-64. Second, the Army's current plans are to train all AH-64 aviators to perform both the pilot and the CPG functions (Browne, 1981). This decision is based on (a) a desire for maximum operational flexibility, and (b) the assumption that individuals who possess the abilities to perform effectively in one crew position will also be able to perform effectively in the other crew position.

NEED

The AH-64 subsystems are so different and so much more complex than the subsystems in other Army helicopters that there is a strong reason to suspect that effective performance in the AH-64 may require that AH-64 crew members possess abilities above and beyond those required to perform effectively in other Army helicopters. Hence, there is a need to determine whether AH-64 crew members must possess unique abilities and, if so, to develop tests that can be used to select individuals who possess the requisite abilities (Human Resource Need, undated).

There is reason to question the assumptions that there is a high degree of commonality in the abilities required for effective performance in the two AH-64 crew positions. Because of the differences in the tasks performed in the two crew positions and because of the differences in the subsystems used to perform these tasks, it is altogether possible that effective performance in the two crew positions may require different sets of abilities that are rarely found in the same individual. As a consequence, there is a need to determine whether or not the abilities required to perform effectively in the pilot position differ in type or extent from the abilities required to perform effectively in the CPG position. If it is found that different abilities are required, a need will exist to develop tests for selecting individuals with the requisite sets of abilities.

PROJECT OBJECTIVES

As is suggested by the title, the general objective of this project is to define prerequisites and selection criteria for AH-64 crew members. The specific technical objectives are as follows:

- identify for each crew position the critical crew functions required to perform the attack helicopter mission,
- determine the critical crew functions, if any, that are unique to the AH-64,
- develop for each crew position the predictors of the abilities required to perform the critical functions,
- validate these predictors against performance measures in the AH-64 crew training program, and
- cross-validate the predictors against performance measures in the AH-64 crew training program.

RESEARCH APPROACH

The approach to be followed in this project differs from the traditional approach to aviator selection test development. Instead of a detailed analysis of the aviator tasks, the project will take advantage of a number of task analyses that already have been performed for the AH-64 (Applied Sciences Associates, 1981; Singer Company, 1977;

Applied Psychological Services, 1982). The test development will not deal with the entire inventory of AH-64 crew functions under the assumption that a large proportion of the AH-64 crew functions are the same as crew functions in the AH-1 aircraft. It is further assumed that the same fundamental abilities underlie the functions that are common to both aircraft. If the assumptions are valid, there is no need to develop test instruments to assess common abilities. Since all candidates for AH-64 qualification training are successful AH-1 aviators, it is presumed that all candidates possess an acceptable level of the common abilities. Selection measures developed in this project will be based on crew functions and the underlying abilities that are unique to the AH-64 aircraft.

A job sample test development approach has been selected to complement a separate project presently under way to develop test instruments to select students for the attack (AH-1) training track. That test development effort is based on AH-1 crew functions, so the resulting test instruments will assess the abilities underlying AH-1 crew functions (Myers, Jennings, & Fleishman, 1982). If the Army decides at some future time to select AH-64 aviators from the general population of flying students, it will be possible to base the selection decision on a combination of tests: (a) the fundamental abilities tests developed to select trainees for the attack helicopter training track and (b) the job sample tests developed during this project to assess the job-specific abilities that AH-64 aviators must possess above and beyond the abilities required to pilot the AH-1 aircraft.

Job sample tests were deemed more appropriate for selecting AH-64 crew members from among operational aviators who already have demonstrated that they possess the requisite abilities for flying. Moreover, the high technology hardware associated with the unique AH-64 crew functions provide an identifiable source of job sample test content.

PROJECT STATUS

Work Completed

Project personnel have become thoroughly familiar with the AH-64 attack mission and have completed a comprehensive review of the research literature on aviator selection. Task lists and task analyses conducted during the design and production of the AH-64 system have been collected and used to compile a composite list of AH-64 crew functions.

The composite list of AH-64 crew functions has been formatted into a survey instrument and administered to 27 AH-64 SMEs. The SMEs rated 146 pilot functions and 88 CPG functions on four dimensions: difficulty to learn, probability of deficient performance, frequency of performance, and likelihood that deficient performance will have serious consequences.

The survey data have been entered into a computerized data file. Descriptive statistics have been produced for all 234 ratings. Problems have been encountered in attempting to combine the results from the four survey scales into one overall measure of criticality. A two-way analysis of variance with replications has been performed on the survey data. The significant interaction effects between scales and functions prevents summing mean ratings to derive overall criticality scores for the pilot and copilot functions. Mean ratings and standard deviations were graphically plotted for each of the 146 pilot functions and 88 CPG functions for the four survey scales. Review of the eight plots revealed the full range of ratings were utilized by the SMEs on three of the scales:

- *difficulty of learning,*
- frequency of performance during combat missions, and
- likelihood that deficient performance will have serious consequences.

Ratings on the fourth scale (frequency of deficient performance) were confined to a relatively narrow range. Based upon the data groupings in the first three scales, a decision tree was developed for identifying the critical AH-64 crew functions. The fourth scale was dropped from the analysis under the decision tree approach.

The decision tree methodology consists of four steps:

- select crew functions that are unique to the AH-64 and eliminate crew functions that are similar to the AH-1;
- select crew functions in the top levels of the "difficulty of learning" scale and eliminate crew functions in the lower level(s);
- select crew functions in the top levels of the "frequency of performance during combat missions" scale and eliminate crew functions in the lower level(s); and
- select crew functions in the top levels of the "likelihood that deficient performance will have serious consequences" scale and eliminate crew functions in the lower level(s).

Sixty-five of the pilot functions were categorized as similar and 81 were categorized as unique. Among the copilot/gunner functions, 12 were categorized as similar and 66 were categorized as unique.

Two decision trees were developed. Overall mean ratings and standard deviations for each rating scale were used to establish quantitative limits for each branch of the decision tree. The pilot function decision tree consists of four different levels (branches) of the "difficulty to learn" scale, three different branches of the "frequency of performance" scale, and three different branches of the "likelihood that deficient performance will have serious consequences" scale. The copilot/gunner decision tree consists of three different branches of the "difficulty to learn" scale, three different branches of the "frequency of performance" scale, and three different branches of the "likelihood that deficient performance will have serious consequences" scale. Thus, there are (4x3x3) 36 levels in the final step of the pilot function decision tree and (3x3x3) 27 levels in the final step of the copilot/gunner function decision tree.

Each pilot and copilot/gunner function was entered into the decision tree using the following procedure:

- the mean rating on the "difficulty to learn" scale was used to assign the function to the proper branch of the "difficulty to learn" portion of the tree;
- from that level, the mean rating on the "frequency of performance" scale was used to assign the function to the proper branch of the "frequency of performance" scale; and

- from that level, the mean rating on the "likelihood that deficient performance will have serious consequences" scale was used to assign the function to the proper branch of the "likelihood that deficient performance will have serious consequences" scale.

The final step resulted in the sorting of the 146 pilot functions into 36 different levels of criticality and the 88 copilot/gunner functions into 27 different levels of criticality.

Projected Completion Date

AH-64 aircrew qualification training will start at Fort Rucker on 1 January 1985. Identification of the critical crew functions and development of the predictor test battery will not be completed in time to select the first students for training. Thus, the Army will revert to traditional personnel selection procedures.

Early in FY 1985, selected Anacapa researchers will discuss the AH-64 data analysis problems in an informal colloquium. The goal of the colloquium will be to identify additional approaches to analyzing the AH-64 survey data and to develop a data analysis plan.

The data analysis plan will be implemented and results reported in a report to ARI by 31 March 1985. At that point, a decision will be made regarding whether to proceed with the development of job sample tests for AH-64 selection.

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DEVELOPMENT OF A 1984-85 VERSION OF THE ARMY FLIGHT APTITUDE SELECTION TEST

Mr. D. Michael McAnulty, Project Director

This research project is a part of a continuing ARI effort to increase the effectiveness of the tests used to select applicants for the Army Initial Entry Rotary Wing (IERW) training program.

BACKGROUND

The Army's original selection battery, the Flight Aptitude Selection Test (FAST), was developed in response to the unacceptably high attrition rates in the flight training program during the 1950s. The FAST was composed of two test batteries, one for officer applicants and one for enlisted/civilian applicants. Each battery yielded a fixed-wing and a rotary-wing aptitude score for each applicant (Kaplan, 1965). The FAST, implemented in 1966, resulted in a substantial reduction in the IERW attrition rates.

In 1975, the U.S. Army Aviation Center requested a revision of the FAST due to (a) a decrease in the validity of the FAST (Eastman & McMullen, 1978a), (b) the large number of errors in scoring the FAST, (c) the excessive amount of time required to administer the FAST, and (d) the elimination of fixed-wing training for initial entry students. The goal of the revision was to develop a single, effective battery with fewer, shorter, and more reliably scored subtests (Eastman & McMullen, 1978b).

The methodological approach chosen for the revision was to select the most effective subtests from the FAST, and then to select the most effective items from each subtest for inclusion in a Revised FAST (RFAST). Factor analyses and multiple regression analyses were used to select seven of the 12 FAST subtests for retention. Subsequently, item difficulties and item discrimination coefficients were analyzed to identify specific subtest items to be retained. The length of each subtest was reduced to approximately one-half the original length. The RFAST became operational in 1980.

PROJECT OBJECTIVES

The objectives of this project are to evaluate the RFAST and to develop a more effective battery of selection tests. The specific technical objectives of this research are to:

- identify an improved criterion measure of student performance in IERW,
- conduct a detailed statistical analysis of the RFAST,
- identify the abilities required to complete IERW successfully,
- identify the abilities being assessed by the RFAST, and
- develop an improved version of the Army's FAST.

RESEARCH APPROACH

The first phase of the research is designed to evaluate the reliability, validity, and factorial structure of the RFAST and its subtests. The required analyses include (a) the computation of item difficulty and discrimination indices, (b) the computation of reliability coefficients for each subtest and the total battery, (c) a factor analysis of the 200-item battery, and (d) the computation of validity coefficients for each subtest and the total RFAST scores. Previous validation efforts have used a pass-fail criterion, but this dichotomy has been found to be an insensitive measure of training performance. Therefore, the identification of an improved criterion measure is required before the validity analyses can be conducted.

The second phase of the research is designed to determine if the RFAST assesses the full range of abilities that are required to complete IERW training. This evaluation requires (a) the conduct of a task analysis to identify the requisite abilities, (b) the quantification of the relative importance of the requisite abilities, and (c) the conduct of an analysis to identify the requisite abilities that are measured satisfactorily by subtests on the RFAST.

The third phase of the research project consists of traditional test development activities. Based on the item and subtest analyses, subtests from the current RFAST will be eliminated or modified as

necessary to increase reliability and validity. Using the data from the abilities analyses, additional subtests will be developed for inclusion in the future version of the RFAST. Once the updated version is developed, preliminary tests will be conducted to ensure that the subtests are functioning as designed. Additional data will be collected and statistical analyses will be performed to examine the reliability and validity of the updated version. The final activity will be to compile two parallel versions of the updated RFAST and to develop all ancillary materials, including test administration manuals, directions, answer sheets, and scoring keys.

PROJECT STATUS

Work Completed

The statistical analyses of the RFAST have been completed. The results indicate that the current RFAST is a heterogeneous battery composed of six homogeneous subtests and one heterogeneous subtest. The heterogeneous subtest, Self-Description, is uncorrelated with the total battery score. With the exception of the Self-Description subtest, all subtests have acceptably high reliability coefficients, ranging from .64 to .88. The reliability coefficient for the total battery is .90.

Efforts to evaluate criterion measures resulted in the derivation of a "benefit resulting from exposure to training" measure (Lockwood & Shipley, 1984). The derived measure is a transformed ratio of actual flight training time to scheduled flight training time. The multiple correlation between the RFAST subtests and the benefit criterion measure yielded a validity coefficient of .21 for the initial validation sample and .11 for the cross-validation sample. The simple correlation between RFAST total score and the benefit criterion was .17 (r = .25 corrected for range restriction and criterion attenuation). Although the validity coefficients are statistically significant, the low percentage of variance accounted for by the current RFAST indicates the battery has limited utility in predicting IERW performance. A technical report (Lockwood & Shipley, 1984) has been prepared and submitted to ARI to document the first phase of research.

A procedure to identify the ability requirements for successful completion of IERW has been developed and the data collection and analyses have been completed. The procedure required experienced IERW instructor pilots (IPs) to (a) identify the tasks that are most indicative of successful performance in the primary and instrument phases of IERW, and (b) judge the type and importance of the abilities that are required to perform each task. The ability definitions and rating technique developed by Fleishman and his associates (e.g., Theologus & Fleishman, 1973) were used to obtain IP judgments of the ability requirements for each task. The task-ability ratings for each IP were then transformed to a normally distributed, equal-interval scale using the method of successive intervals (Hays, 1967). Analyses of the transformed ratings indicated that 24 abilities from the psychomotor, perceptual, language, and cognitive domains were required for successful performance in IERW.

Concurrently, research psychologists, using the Fleishman ability requirements technique, determined that three RFAST subtests adequately assess three of the required perceptual abilities. Of the remaining 21 required abilities, 10 were selected for new subtest development on the basis of (a) potential for reliable and valid measurement, and (b) amenability to assessment in the current test format. A test specifications matrix has been developed to guide the phase three activities in developing an improved version of the FAST battery. A technical report that documents the second phase of research has been prepared and submitted to ARI (McAnulty, Jones, Cohen, & Lockwood, 1984).

Projected Completion Date

Current efforts involve the development of new subtests and the adaptation of current subtests. The development and evaluation of the selection battery will be completed by December 1986.

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DEVELOPMENT OF A METHODOLOGY FOR GENERATING A FLIGHT GRADING SYSTEM

Mr. Theodore B. Aldrich, Project Director

BACKGROUND

IPs responsible for training in the Combat Skills course of the U.S. Army's IERW training program have expressed considerable dissatisfaction with the gradeslip presently being used and have requested that ARI provide support in developing and evaluating an improved gradeslip (Shipley, 1981). Preliminary investigation revealed that the gradeslip was only one part of a more general problem. As a result, project personnel recommended that the scope of the project be expanded to encompass all aspects of the Combat Skills grading system. The project description presented below reflects the intention to investigate the full range of problems associated with the Combat Skills grading system.

NEED/PROBLEM

Many of the traditional problems associated with flight grading systems are manifest in the U.S. Army's flying training program. Four problems considered especially crucial are discussed below. First, daily flying lessons and periodic check flights within the IERW training programs are graded using a four-increment scale (A, B, C, or U). The standards for the four increments are stated in descriptive terms and allow for a range of individual IP judgments. The regulation prescribing the grading procedures calls for criterion-referenced grading; and yet, the same regulation (U.S. Army Aviation Center, 1970) directs IPs to adjust grading standards to correspond to the student's phase of training.

Second, the gradeslip lists the maneuvers to be graded, but the rationale for including the maneuvers on the gradeslip is obscure. The maneuvers listed on the gradeslip do not correspond exactly with either the maneuvers contained in the training syllabus or those listed in the ATM. Apparently, this lack of correspondence is the result of training

managers' failure to modify the gradeslip in step with changes to the training syllabus. This failure raises questions about training managers' requirements for grade information and suggests that management information requirements for grades be identified and specified during the design of the grading system.

Third, there are a number of human factors design deficiencies in the gradeslip. Grouping of items is not functional and the large number of graded items are crowded onto a small form by reducing the type size below established legibility standards.

Finally, the Combat Skills IPs receive limited and ineffective training on performance evaluation and grading. New IPs develop their individualized set of evaluation criteria based upon informal discussions with more experienced IPs and upon their own experience from flight school and operational flying assignments.

PROJECT OBJECTIVES

This project has two broad objectives. The first objective is to develop and implement an improved grading system for the Combat Skills course. The second objective is to test a methodology for developing improved flight grading systems. A key attribute of this methodology is that experienced IPs play an important and continuous role in all aspects of the design process.

A set of secondary objectives, aimed at eliminating specific deficiencies in the present grading system, will be addressed during the development of the improved grading system. The secondary objectives include:

- define specific grading criteria and standards,
- design a gradeslip that satisfies management information requirements and that complies with human factors standards,
- develop a grading scale that contributes to interrater reliability and allows the IP to accurately record the grades in accordance with the established standards, and
- develop a training program that instructs IPs and check pilots on how to grade flight performance accurately and consistently.

RESEARCH APPROACH

The approach to be followed in this project is described below in three phases: design and pretest, test and evaluation, and implementation.

Design and Pretest

Design of the grading system will be accomplished through a series of consensual decision-making design meetings involving eight Combat Skills IPs and four IPs assigned to key training directorates at USAAVNC. Design features will be decided by IPs during consensual decision-making design meetings. Design decisions will be made about such features as the scale, the items to be graded, the system for calculating an overall grade, the frequency of grading, and the format for the gradeslip. Project personnel will accomplish the following tasks prior to the first design meeting:

- conduct an audit of the training management information system for the purpose of documenting the requirements for flight grades,
- perform a content analysis of the combat skills maneuvers,
- develop human factors specifications to be used as design constraints for the design of the gradeslip, and
- develop grading system design guidelines.

The results from these tasks will be provided to the IPs as guidelines and factors to be considered in their design decisions.

The IPs who design the grading system will pretest the system by participating in flight tests in an instrumented helicopter. Results of the flight tests will be reported at subsequent design meetings and used to refine the grading system design. The flight tests also will be used to refine procedures to be used in the test and evaluation phase.

A program to train IPs on the new grading procedures and materials will be developed as the prototype grading system design nears completion. Video tapes, recorded during the flight tests, will serve as visual aids in the program.

Test and Evaluation

The test and evaluation phase will feature operational use of the prototype grading system during simultaneous inflight grading of students by two IPs. Prior to the inflight grading, participating IPs will be introduced to the prototype grading system through the training program developed earlier. The inflight grading will be performed initially in the Method of Instruction (MOI) course used to train rated aviators to be Combat Skills IPs and subsequently in the Combat Skills Course of Instruction (COI) with actual students. After each flight, the two IPs will be asked to resolve their differences in grading through discussion of the student's performance on the graded items. Video tape recordings of the inflight maneuvers will be provided to assist the IPs in resolving their differences.

Additional pairs of IPs will be asked to grade the recorded maneuvers based only on the information they can derive from viewing the video tapes. Differences in grades, assigned during the video grading, will be resolved through consensual decision-making.

A fundamental assumption underlying this project is that the discussions IPs engage in to resolve differences in assigned grades will reveal valuable information about performance criteria and standards. Consequently, project personnel will be present at all discussions that IPs engage in to resolve grading differences, and will record information bearing on (a) the set of flight parameters that IPs consider in evaluating performance on a given maneuver, and (b) the relationship between assigned grades and the amount by which a flight parameter deviates from its command or "nominal" value. In short, all information will be recorded that may prove useful in defining performance criteria and standards.

The data compiled during this phase of the project will be analyzed and the results used to define tentative performance criteria and standards for each Combat Skills maneuver to be graded. In addition, the data on initial assigned grades will be used to measure the level of interrater reliability that exists prior to the introduction of the new grading system.

A series of design review meetings will be held to review the composite findings to this point in the project and to make final decisions about all aspects of the grading system. This series of meetings will be attended by a group of IPs selected from among those who participated in either the inflight grading or the video tape grading. The products that are expected tc result from the design review meetings include:

- a listing of the individuals/agencies who use information on flight grades and the purposes for which they use the information,
- a listing of the flight maneuvers that are to be graded by Combat Skills IPs,
- a definition of the performance criteria and standards for each maneuver to be graded,
- a description of all grading procedures and materials,
- a description of the flow of information on grades throughout the training management system, and
- a complete training program design for use in training Combat Skills IPs to use the recommended grading procedures and materials.

Implementation

The third phase of the project consists of implementing the new grading system throughout the Combat Skills course. The training program on grading and performance evaluation will be administered to all Combat Skills IPs. Thereafter, the training program will be taught regularly as a part of the MOI course so that new IPs will be instructed properly on the subject of grading and performance evaluation.

A final report that describes all of the project activities and results will be written. The report will contain conclusions about the applicability of the project's methodology to other flight grading programs.

PROJECT STATUS

Work Completed

Considerable planning has been completed for this project. An issues paper has been written that reviews the relevant performance measurement literature and discusses the problems encountered when developing a new grading system within an operational environment. An analysis of the deficiencies in the existing grading system has been completed and a set of design criteria for the new system has been developed. Included in the design criteria are the major human factors considerations that will constrain and guide the grading system design.

An outline plan for conducting the project has been prepared in the form of a task flow diagram. Resources required for the duration of the project have been spelled out in fine detail. Manpower and logistic resources have been estimated for each step of the project on a weekly timeline.

One of the primary resource requirements is an instrumented UH-1 helicopter and an instrumentation package to support the inflight tests. An available helicopter and an instrumentation package adaptable for the project have been located, and preliminary commitments of support have been obtained.

IP manpower is another key resource required for this project. A briefing on the research plan has been presented to a group of Combat Skills IPs; the plan received their tentative endorsement. A subsequent briefing was presented to the Lowe Training Division Commander who is responsible for the Combat Skills course. He stated that he could not commit the required IPs to the project because present IP resources constitute only 75% of the authorized manning level. He suggested that project personnel further investigate the utility of the instrumented helicopter and informally discuss the grading system problems with IPs on an as-available basis until IP strength is increased to a level that will allow assignment of IPs to the project.

Rather than delay the project, a decision was made to conduct a pilot study using ARI/ASI IP resources and an instrumented helicopter available from the U.S. Army's Aviation Test Activity at Cairns Field. The objectives of the pilot test are to investigate the feasibility of the following:

- engaging IPs in consensual decision-making exercises leading to the design of a prototype gradeslip,
- inflight grading using the prototype gradeslip,
- recording student performance on video tape in flight, and
- grading student performance from video tape collected in flight.

A series of consensual decision-making meetings with the three IPs from ARI/ASI was conducted from January through March 1983. The consensual decision-making approach to the design of a gradeslip proved to be very time consuming. Eighteen separate meetings were required before the three IPs completed their gradeslip design.

ARI contracted with the Test Activity for technical support and five hours of flying time in the instrumented helicopter. Project personnel identified performance measurements to be collected and consulted with the Test Activity about the optimum placement of three video cameras. One camera was mounted on the nose of the helicopter and recorded a forward field-of-view 87 degrees wide. A second camera was mounted above and to the rear of the left pilot's head and was directed at the student pilot. A third camera was focused on a specially constructed "little theater" in which an array of repeater flight instruments could be video recorded. All three cameras were connected to video recorders. A time signal generator was provided to project a time onto each recording.

The IPs assigned to the project designed a combat skills test mission to be flown in the instrumented helicopter. The mission consists of 44 segments and was planned to fill a two-hour period.

Lowe Division officials, responsible for the Combat Skills course, provided fledgling IPs to serve in the test as volunteer student pilots. Video cameras and recorders were operated during two flight tests.

During the first flight test the cameras directed toward the subject and the little theater were connected to two-hour recorders and were operated continuously. The nose camera was connected to a 30-minute recorder that operated intermittently during critical performance segments. Two IPs graded the subject's performance and entered their grades on the prototype gradeslip. They discussed their grades and reached consensus for many of their differences. A third IP viewed the video tapes, graded the student's performance, and provided his comments about the utility of the video tapes. He was able to grade the student from information acquired solely through the video tapes. There was a high degree of agreement between his grades and the grades provided by the IPs who had observed the flight.

Minor redesign of the prototype gradeslip was accomplished as a result of the comments collected from the IPs who had performed the grading on the first flight test.

Review of the video tapes resulted in the identification of several changes required to improve the quality of the recordings. Recommended modifications include:

- improve the focus and/or lighting for the camera directed at the little theater,
- dampen the vibration for the camera directed at the subject pilot,
- troubleshoot and repair the pitot pressure line to the airspeed indicator in the little theater, and
- substitute a different multiplex unit and/or time signal generator in order to provide readable time codes on both the little theater and subject-pilot videotapes.

The Test Activity agreed to implement the above improvements for the second test flight. The multiplex unit previously used to combine video from the little theater camera and the student camera onto one recorder was eliminated. Each camera was linked to an independent two-hour recorder. Also, the recorder for the nose camera was changed to provide a full two-hour capability. Without the multiplex unit, the time code appeared on only two of the tapes. However, the three video recordings were initiated by a single switch and were in close synchrony

from the start. A different camera was installed for the "little theater" scene. The camera position was moved closer to the panel so the instruments could be read more clearly.

During the second test flight the two IPs exchanged the flight position they filled during the first flight, with one serving as the IP at the controls (left seat) and the other as the IP observing from behind the left seat. The video cameras from all three cameras were of improved quality in comparison to those of the first flight. Flight test results were discussed with the Test Activity planners and agreement reached that the flight test portion of the pilot study had been completed.

Summary findings are listed below.

- A Combat Skills gradeslip can be designed by involving a group of IPs in a series of consensual decision-making meetings. However, the number of meetings and time required to accomplish this effort is greater than estimated when planning for the project.
- IPs are able to grade student performance by reference to video tapes of student performance recorded in flight. Video tape and audio tape from the test missions provide enough detail to accomplish grading.
- IPs are able to grade from a jump seat, located behind the left pilot's seat, normally occupied by the IP. In fact, both IPs commented that they were able to observe student performance better from the jump seat location.
- The Test Activity is not able to provide the technical support required to provide an instrumented helicopter on a dedicated daily flight schedule, as required by the project research plan.
- The video tapes have good potential value for use in developing instructional material for courses on grading to be presented to newly assigned IPs.

A draft report has been written and reviewed. Extensive revision is required before publication. Revision has been deferred to permit work on higher priority research. A copy of the draft report has been provided to the ARI point of contact for use in planning other performance evaluation research.

Projected Completion Date

Revision and publication of the draft report is the only work pending at the end of Fiscal Year 1984. Tentative plans call for completion of the report by 31 January 1985. Future direction to be taken in this project will be reviewed at that time.

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CONVERSION OF ADVANCED MAP INTERPRETATION AND TERRAIN ANALYSIS COURSE (MITAC) TO VIDEODISC FORMAT

Mr. Claude O. Miles, Project Director

BACKGROUND

Proficiency in map interpretation and the ability to navigate accurately by means of visual pilotage are of paramount importance when conducting a nap-of-the-earth (NOE) mission on the modern battlefield. However, a study conducted by the U.S. Army Research Institute (ARI) in 1975 revealed that a large proportion of Army aviators were deficient in the skills necessary for accurate navigation at NOE altitudes (Fineberg, Meister, & Farrell, 1978). In an effort to alleviate this problem, ARI sponsored a project to develop new training methods and materials aimed at improving aviators' map interpretation and navigation skills. The end result was the development of a prototype basic Map Interpretation and Terrain Analysis Course (MITAC). This course focuses on the key principles that must be understood in order to navigate accurately at NOE altitudes when features are partially or totally obscured by terrain, vegetation, or man-made objects.

The objective of the course was to train Army helicopter pilots the map interpretation skills necessary to navigate accurately when flying at NOE altitudes over unfamiliar terrain. The course was designed to be administered by a trained instructor. A self-instructional version of the basic MITAC (MITAC II) was developed for use in unit training. This package was later converted to the Training Extension Course (TEC) format for use in the Bessler Que/See.

The navigational exercises require the student to perform a preflight map study of the area of operations, listen to a commentary on preflight map study, view the filmed route and simultaneously mark checkpoint positions on the map. The student is then required to check and score performance, and watch the film a second time while listening to a debriefing commentary.

In 1977, an evaluation conducted by ARI revealed that students who underwent MITAC training navigated at twice the speed along NOE routes with one-third the errors of conventionally trained students (Holman, 1977). It was subsequently recommended that all aviators with NOE flight requirements undergo basic MITAC training. Presently, student aviators in the Army's IERW course receive basic MITAC in the academic portion of their training.

In 1977, Anacapa Sciences, Inc. (ASI) was contracted to develop a set of Advanced MITAC lessons aimed at exposing students to more difficult exercises. These lessons would expose students to a greater variety of geographical coverage, seasonal changes, and maps compiled by foreign cartographers. Thirteen Advanced MITAC lessons were developed covering various types of topographical conditions in Arizona, Idaho, Kentucky, and Germany. The exportable self-instructional training package for these lessons include:

- annotated 16-mm color filmed routes,
- preflight and debriefing commentaries recorded on audio cassettes,
- a self-instructional manual,
- map plates, and
- map plate overlays used for scoring performance.

NEED/PROBLEM

In 1982, interest was directed toward laser videodiscs as an alternative medium for presenting MITAC training material. As a result, ARI assigned ASI the task of producing a demonstration laser videodisc of one of the Advanced MITAC lesson for use in demonstrating the new form of training technology and its capabilities over presently used audio-visual systems. In May 1982, an evaluation of the videodisc revealed the following advantages over conventional training methods:

- high quality video and audio reproduction;
- no degradation with use because nothing actually touches the disc;

- the capabilities of automatic picture and chapter stop, freeze frame, slow or fast motion, frame-by-frame forward or reverse stepping, and rapid access to any frame or chapter on the disc;
- two audio tracks that can be used simultaneously, individually (as in a bilingual situation), or muted;
- thirty minute programming in the Constant Angular Velocity (CAV) mode or 54,000 individual frames per side;
- limited interaction capability; and
- reduction of cost for expensive equipment for demonstration and training.

The main disadvantage of videodisc technology is the large investment in time and resources required to produce videodiscs. The cost effectiveness of videodisc production is greatly influenced by the number of copies produced from the master disc, since the main cost is associated with the production of the master disc.

PROJECT OBJECTIVE

An evaluation of a prototype disc led to the conclusion that the advantages of laser videodiscs more than offset the disadvantages, and that video disc technology constitutes an excellent training medium for the Advanced MITAC. As a result, ARI directed ASI to convert the 13 Advanced MITAC lessons from 16-mm film to videodisc format and to provide complete supplementary exportable self-instructional packages containing supplementary course materials. The production of the videodiscs was executed in three phases.

VIDEODISC PRODUCTION

Phase I: Program Design/Production

Program design and production procedures included the definition of detailed program objectives, the development of storyboards specifying picture and sound sequences, and the production of video tapes (from 16-mm film) and audio tapes of program segments.

Phase II: Premastering

The company chosen for premastering and overseeing disc development was Digital Video Corporation in Orlando, Florida. Digital Video Corporation produced the one-inch Type C video tapes to be submitted for mastering and replication. Premastering included the transfer of program material from tape, film, and slides onto a one-inch video tape. Color and contrast correction, cue instructions, and editing were accomplished during this phase.

Phase III: Mastering and Replication

The production of the videodiscs was performed by 3-M in St. Paul, Minnesota. The master tapes received from Digital Video were checked for adherence to specifications. The master discs were then pressed and replicated in specified quantities. Check discs were sent to Digital Video and ASI to be checked for conformance to specifications and for errors that might have occurred during the premastering or mastering and replication phases. Some problems were encountered, but were corrected.

PROJECT STATUS

Work Completed

The discs have been produced, received, and checked. Complete exportable training packages containing supplementary course materials have been prepared and are ready for use. Two 12-inch, one 19-inch, and one 25-inch Sony Trinitron monitors have been acquired. Five Sony LDP 1000-A videodisc players and two microprocessors have also been purchased for use with the project.

A six-week research project will be conducted by Mr. Bob McMullen, ARI, and Mr. Claude Miles, ASI, to evaluate the effectiveness of the three different size monitors as well as the contents of the training packages. The test will be conducted with student aviators at Fort Rucker, Alabama.

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ANALYTIC ASSESSMENT OF NATIONAL GUARD AVIATOR TRAINING REQUIREMENTS

Dr. John W. Ruffner and Dr. Sandra S. Martin, Project Directors

BACKGROUND

An aviator in the Army National Guard (ARNG) must fulfill the same annual training requirements as an aviator in the active Army. The requirements are outlined in the Aircrew Training Manuals (ATMs) for individual training and in the Army Training and Evaluation Program (ARTEP) manuals for collective unit/combined-arms training. Both ATM and ARTEP requirements have changed significantly since the early 1970s, when most ARNG aviators presently in the force were originally trained. Moreover, the ARNG aircraft fleet has been modernized significantly since that time and several additional aviator training requirements have been added. The major requirements that have been added are the following:

- instrument qualification,
- NOE qualification,
- unaided night tactical training,
- NVG qualification
- qualification in aircraft specific to the ARNG (e.g., CH-54, OH-6), and
- attack helicopter systems qualification (e.g., UH-1M, AH-1G).

The U. S. Army Aviation Center (USAAVNC) at Fort Rucker, Alabama, no longer offers any of the additional qualifications as a specific course. Therefore, the aviator must obtain the training necessary to meet the requirements by using National Guard support personnel and facilities during his/her available training time. Yet, the amount of paid training time that is authorized for the ARNG aviator has remained constant since the early 1970s.

Authorized training time for ARNG aviators may be categorized into three major types of training periods.

- **Unit Training Assemblies (UTAs).** A UTA consists of a four-hour training period. Four UTAs are typically scheduled consecutively to constitute a weekend drill period. In this case, the training periods are referred to as Multiple Unit Training Assemblies (MUTAs). MUTAs typically are used for collective unit (ARTEP) training, rather than individual training. ARNG aviators are authorized 48 UTAs per calendar year.

- **Additional Flight Training Periods (AFTPs).** An AFTP consists of a four-hour period that is typically used to maintain individual crewmember skills and to accomplish the hands-on flight components of the Annual Aviator Proficiency and Readiness Test (AAPART). ARNG aviators are authorized 24 AFTPs per calendar year.
- **Annual Training (AT).** Annual training periods typically are used for collective unit and combined-arms training employing a threat-oriented scenario. Emphasis is placed upon unit operations tasks to ensure effective internal command, control, and communications, as well as external coordination with higher headquarters or supported units. ARNG aviators are authorized 15 days of AT.

In addition, another type of training period, Full Time Training Duty (FTTD) day, can be scheduled for training in the Synthetic Flight Training System (SFTS) and for special missions. FTTDs are scheduled and approved on a case-by-case basis.

NEED

The training requirements that the ARNG aviator must meet have significantly increased over the last ten years, while the training time available to the ARNG aviator has remained constant. Therefore, a need exists to determine if the current training requirements can be met in the amount of training time presently available to the ARNG aviator.

The increase in training requirements may be a major factor influencing ARNG aviators to leave the National Guard. The potential effect of the additional training requirements on the attrition of ARNG aviators is especially critical in view of the "aging of the force." Approximately 55% of the ARNG aviators are between 34 and 39 years of age. In addition, within the next five years, about 15% of the ARNG aviators will be eligible for retirement with 20 years of military service. When these aviators leave the ARNG, a considerable amount of experience and expertise will be lost. Without the expertise of the older aviators, unit commanders may find that it is increasingly difficult for the younger, less experienced ARNG aviators to meet current training requirements.

The National Guard Bureau has tasked ARI to provide information about (a) the ARNG aviators' ability to meet current training requirements in the amount of time presently allocated for meeting the requirements, (b) demographic and attitudinal factors that affect the ARNG aviators' ability to meet the requirements during the allocated training time, and (c) the ARNG aviators' willingness to spend additional time to meet the training requirements. The information will be provided for each of the following types of ARNG aviation units:

- Attack Helicopter Company/Troop,
- Air Cavalry Troop,
- Combat Support Aviation Company,
- Aviation General Support Company,
- Aerial Surveillance Aviation Company,
- Air Ambulance Detachment, and
- Transportation Company.

PROJECT OBJECTIVES

The ARNG aviation training requirements research has six specific objectives. The objectives are listed below:

- to determine the ARNG aviators' ability to meet the current training requirements in the amount of training time that is presently allocated;
- to determine the ARNG aviators' willingness to spend additional time to meet the training requirements;
- to identify specific factors--e.g., demographic characteristics, attitudes, civilian job requirements, family influences, and training obstacles--that affect the ARNG aviators' ability to utilize the currently allocated training time for meeting the training requirements;
- to identify specific factors--e.g., demographic characteristics, attitudes, civilian job requirements, family influences, and training obstacles--that affect the ARNG aviators' willingness to spend additional time to meet the training requirements;
- to determine the relationship between the ARNG aviators' career intentions and each of the following factors: ability to meet the training requirements in the allocated training time, willingness to spend additional time to meet the training requirements, total time spent in meeting the training requirements, demographic characteristics, civilian job requirements, and family influences; and

- to determine the relationship between the amount of time that is allocated to meet the training requirements and the amount of time that is actually spent in meeting the requirements.

These objectives will be met for each of the seven major types of ARNG units, as well as for the total ARNG force.

RESEARCH APPROACH

The research approach developed to meet the project objectives has three phases. In Phase I, information concerning training requirements, demographic variables, and career intentions will be obtained by means of a questionnaire to be completed by all ARNG aviators. In Phase II, information concerning time required to meet ARNG training requirements will be obtained using an optically scannable data collection form. In Phase III, analyses of data obtained in Phase I and Phase II will be conducted. A more detailed account of the methodology developed for each of the three phases is given in the following sections.

Phase I. ARNG Aviator Questionnaire

A questionnaire has been developed to assess demographic variables that may affect the capability and willingness of ARNG aviators to meet current training requirements in the time available. The questionnaire consists of the three parts described below.

Part I. Current training requirements. In Part I of the questionnaire, aviators are required to rate the following variables concerning training requirements:

- adequacy of the current training requirements for maintaining a safe level of proficiency,
- adequacy of the time allocated for meeting the training requirements,
- willingness to spend additional paid time to meet the training requirements,
- willingness to spend additional nonpaid time to meet the training requirements, and
- factors that serve as obstacles to meeting the training requirements.

Part II. Demographic characteristics. In Part II of the questionnaire, the aviators are required to provide information about the following demographic characteristics:

- personal characteristics (e.g., age, education),
- military characteristics (e.g., aircraft qualifications, military experience),
- civilian employment (e.g., income, supervisor's attitude toward ARNG), and
- family factors (e.g., employment of spouse, family attitudes toward ARNG).

Part III. National Guard career intentions. Part III of the questionnaire requires aviators to provide information about the following aspects of their career intentions:

- intentions to stay in or leave the ARNG,
- factors influencing the intention to remain in or leave the ARNG,
- satisfaction with the ARNG, and
- general comments about the ARNG.

Phase II. ARNG Aviator Training Log

In Phase II, information will be obtained concerning the time necessary to meet the existing training requirements. An optically scannable, computer-scored data collection form (Training Log) has been custom designed to provide ARNG aviators the opportunity to report hours spent on flying and nonflying activities during different types of training periods. The aviators will report the time spent in each of the following flying activities:

- meeting ATM minimum iteration requirements and checkrides not as part of ARTEP training (Combined Arms/Collective),
- meeting ATM minimum iteration requirements during ARTEP training,
- meeting ARTEP training requirements exclusive of ATM minimum iteration requirements,
- inflight training and/or evaluation of other aviators exclusive of ATM minimum iteration requirements, and
- performing miscellaneous flight activities exclusive of ATM minimum iteration requirements.

Aviators will also report time spent in each of the following nonflying activities:

- performing required additional duties (e.g., supply officer, motor officer, administrative duties),
- completing and administering military education, common soldier skills, and career development training (e.g., correspondence courses, academic aspects of aviation qualifications/ transitions),
- performing pre-post flight tasks (e.g., pre-post flight, planning, weather/mission briefs, flight records),
- preparing for, undergoing, and administering oral and written nonflying aviation evaluations (e.g., annual writ, -10 test, flight physicals, checkrides), and
- performing miscellaneous nonflying activities (e.g., crew rest, dead time, inspections, meals, formations).

The aviators will report the time spent on each of the activities described above during the following types of training periods:

- Unit Training Assembly,
- Additional Flight Training Period,
- Full Time Training Duty,
- Annual Training,
- Year Round Annual Training,
- Additional Training Assembly, and
- Split Unit Training Assembly,

In addition, aviators will report time spent on a nonpay status at the National Guard facility, and on a nonpay status away from the National Guard facility (e.g., home, office).

Phase III. Consolidation of Questionnaire and Training Log Data

Data obtained from the questionnaire and the Training Log will be analyzed during Phase III. The primary products from the analysis of the questionnaire data will be the following:

- a summary of descriptive statistics and one-way frequency distributions for questionnaire items,
- cross-tabulation tables for selected combinations of categorical variables (e.g., career intentions by rank), and
- correlations between selected pairs of continuous variables (e.g., adequacy of time allocated by willingness to spend additional nonpaid time).

Analyses will be performed separately for each of the seven types of ARNG units described previously.

The primary products from the analysis of the Training Log data will be a summary of descriptive statistics for each of the flying and nonflying categories, classified by type of training period. The descriptive statistics will be calculated after the sixth and twelfth months of Training Log data collection and will be reported separately for each of the seven types of ARNG units.

PROJECT STATUS

Work Completed: Phase I

During the first part of the contract year, pretesting of the questionnaire and Training Log was completed. The forms were revised based on feedback obtained during the pretest. The questionnaires were sent to the ARNG facilities during January and February 1984.

Data collection for Phase I has been completed. A total of 3,640 questionnaires, representing 77% of the ARNG aviator population, were returned. Data from the questionnaires were entered into a data base and verified. By the end of the contract year, preliminary analyses of the data had been completed. During May and September 1984, the results of the analyses were briefed to the National Guard Bureau and to Brigadier General Richard Dean, Deputy Commander of the Army National Guard.

The questionnaire has provided the following types of information about ARNG aviators: demographic characteristics, career intentions, training requirements, and obstacles to training. The major results of the data analysis are summarized in the paragraphs that follow.

Demographic characteristics. The median age of ARNG aviators is 37.1 years. The aviators have a median of 2000 total military flight hours and a median of 14 years of combined active duty, reserve, and National Guard military experience. Fifty-five percent of the aviators have at least a four-year college degree. One-half of the aviators

spend a minimum of 50 hours on their civilian job; the median salary from the civilian job alone is approximately $30,000.

Career intentions. Approximately 50% of ARNG aviators intend to stay in the National Guard until they are eligible for 30-year retirement; the median age of this group of aviators is 37.4 years, and the median years of military experience is 14.9. An additional 40% of the aviators intend to stay in until they are eligible for 20-year retirement; the median age of this group is 36.2 years, and the median years of military experience is 11.8 years.

The single most important reason for both joining and remaining in the National Guard is the opportunity to fly. Pay and retirement benefits are somewhat more important reasons for remaining in the National Guard than they are for initially joining the National Guard.

The factor that is most likely to influence the aviators' decisions to leave the National Guard is the loss of flight status. Unrealistic training goals for the time and resources allocated and administrative details and politics were also cited by the majority of the aviators as factors influencing their decisions to leave.

Training requirements. The continuation flight training requirements were judged to be marginally adequate for maintaining a safe level of aviation proficiency. The time allocated for continuation flight training was judged to be clearly inadequate for the night vision goggles task and marginally inadequate for terrain flight tasks, emergency tasks, and night and day tactical tasks. The aviators indicated that they are willing to spend additional paid time to meet all of the continuation flight training requirements.

Obstacles to training. In general, the major obstacles to accomplishing the continuation flight training requirements are an insufficient number of flight hours and the unavailability of instructor pilots. Unavailability of aircraft, unavailability of support equipment, and unavailability of training support areas are obstacles in specific training situations. The training requirement whose accomplishment is impeded by the most obstacles is night vision goggle flying.

Work Completed: Phase II

Training Logs were sent to the aviators in March 1983 to allow familiarization with the form and the reporting procedure. The Training Log has been administered to all ARNG aviators for the first three months of the planned 12-month period. Data from the training log had not been analyzed at the end of the third contract year.

Projected Completion Date

Analysis of the questionnaire data will be completed during the first part of the next contract year. It is anticipated that an interim report describing Phase I activities and results will be available about 1 November 1984.

Data collection for Phase II will continue throughout the next contract year. Draft results for Phase II will be available in September 1985. It is anticipated that the final project report will be available in December 1985.

DEVELOPMENT OF A COMPUTER-BASED SYSTEM FOR CONDUCTING MISSION/TASK WORKLOAD ANALYSES FOR THE ARMY'S EXPERIMENTAL LIGHT HELICOPTER

Mr. Theodore B. Aldrich, Project Director

BACKGROUND

As part of its aviation force modernization, the Army is evaluating the concept of a multipurpose lightweight experimental helicopter, designated the LHX. One of the major design goals for the LHX is that it be capable of performing scout and attack (SCAT) missions with a single crewmember. Some of the potential benefits of a single-crewmember design include:

- a lighter, smaller vehicle;
- increased survivability with a smaller target profile;
- fewer pilot resources for manning the fleet;
- lower training costs; and
- a greater number of flight hours achievable with a given aircraft to pilot ratio.

Improved and highly automated subsystems may make single-crewmember operation feasible. Some of the advanced design features being proposed for the LHX are:

- high technology sensors and target acquisition aids,
- improved navigation and communication systems,
- advanced crew station design features,
- improved flight controls, and
- extraordinary avionics reliability.

The Army is formally evaluating the advanced development concepts for the LHX in a series of trade-off studies and analyses. Human factors, man-machine interface questions are critical to the evaluation. All of the advanced design features listed above have human factor design implications. But, the primary human factors concern being addressed in the LHX trade-off studies is the feasibility of single-crewmember operation.

On 7 July 1983, the Commandant, Army Aviation Research and Development Command (AVRADCOM) tasked the Army Research Institute (ARI) to develop mission/timeline analyses for the SCAT version of the LHX. The tasking message stated that "the ARI analyses will provide a better

understanding of the pilot workload requirements and provide an insight as to which technologies will be required to operate the aircraft effectively in the combat environment and whether these tasks can be successfully accomplished with one pilot or two."

In response to the AVRADCOM message, ARI conducted a preliminary analysis of the LHX performance requirements. A draft report and briefing of the analysis were presented to AVRADCOM on 30 August 1983. AVRADCOM then requested that ARI perform the following additional analyses:

- an analysis for a one-crewmember configuration with a high degree of automation for flight control, target search and acquisition, navigation, and weapon delivery functions (to be completed by 23 September).
- An analysis for a two-crewmember configuration without automation (to be completed by 7 October).

The two additional analyses were completed, and a draft report, subsequently published as an ARI Research Note (McCracken & Aldrich, 1984), was delivered to AVRADCOM during the first week in October 1983.

The results from the initial analyses were rudimentary, but they achieved three objectives by providing:

- a method for evaluating the feasibility of single-pilot operation of the LHX during scout-attack missions,
- analytical material for identifying equipment operations and mission functions where automation can reduce pilot workload and enhance mission performance, and
- approximate first-iteration estimates of workload and performance times at the function level of analysis.

The LHX trade-off studies require that several additional analyses be conducted to evaluate system and subsystem design alternatives. The studies require rapid response in analyzing the various options so that they are performed in phase with the LHX program milestones. Data automation is essential for achieving the requisite timeliness and accuracy. Accordingly, the Commander, AVRADCOM, provided funds on 1 October 1983 to the ARI Fort Rucker Field Unit for the establishment of a computerized data base for LHX mission analysis.

PROJECT OBJECTIVES

The ARI Field Unit directed Anacapa Sciences, Inc., to perform the following tasks:

- program the ARI computer to support entry of mission analyses data and LHX system, subsystem, and mission equipment data;
- enter mission analyses and system, subsystem, and mission equipment data into the computerized data base;
- develop or obtain software, including a simulation model for evaluation of the impact of various systems, subsystems, and mission equipment design alternatives on crew workload and performance times; and
- perform evaluative analyses and provide recommendations regarding the impact of design alternatives on human performance and emerging requirements for LHX aviator training.

APPROACH

The approach adopted for development of the computer-based system consists of two analytic tasks. The first task is to refine the manual analyses completed earlier. The second task is to develop computer programs that will generate workload estimates with greater precision and speed than is possible with the manual analyses. Both analytic tasks address the same mission functions and employ the same subjective estimates of the level of workload imposed by individual tasks that LHX crewmembers must perform to accomplish the mission functions.

In developing the analytic methodology, certain limitations were established. The limitations listed below apply to both the manual analyses and the computer analyses.

- Since specific subsystem design has not yet occurred, subsystems and procedures were viewed in non-specific, generic terms.
- The specificity level of the analyses was limited to the identification of general human performance elements within the mission functions.
- Analyses addressed only primary aeroscout and attack mission functions under normal operating conditions. System failures, visual obscuration, or enemy countermeasures were not addressed.
- Validation of the analyses was limited to content review by subject matter experts.

- Time estimates, workload estimates, and other parameters of the mission functions were based upon the analysts' understanding of current Army doctrine and tactics.
- When estimating workload for the non-automated LHX configuration, the general level of subsystem and weapon technology was assumed to be comparable to that available in the latest Army helicopters, the OH-58D and AH-64A.

PROJECT STATUS

Work Completed--Manual Analysis

Twenty-four LHX (SCAT) profiles, prepared by the Directorate of Combat Developments at the U.S. Army Aviation Center, were examined at the start of the mission analysis. The 24 missions comprise two sets of 12 basic missions. One set consists of 12 missions in a European scenario; the other set consists of the same 12 missions in a Mid-East scenario. The European missions were selected for analysis. The 12 missions are:

- anti-armor,
- anti-personnel/materiel,
- special operations/strike,
- reconnaissance,
- security,
- deep strike,
- rear area consolidation operation (RACO),
- suppression of enemy air defense (SEAD),
- amphibious assault,
- forward aerial artillery observation (FAAO),
- air-to-air (defense), and
- air-to-air (offense).

Project personnel subdivided each mission into phases and subdivided each mission phase into segments. At this stage of the analysis, it became clear that an in-depth workload analysis of each segment of each mission phase was neither feasible nor necessary. Accordingly, a limited but representative sample of mission segments was selected for further analysis. The primary factors considered in selecting the sample of mission segments include: the estimated likelihood of crew overloads, the estimated incidence of crew overloads, the estimated severity of overloads, and the estimated consequences of

overloads. Experienced Army aviators and experienced research personnel contributed to the final selection of the mission segment sample.

Each of the selected segments was dissected into "functions" that must be performed, either by a human operator or by an aircraft equipment component. The functions were then classified into one of three categories and placed on a rough timeline. The three categories of functions are as follows:

- flight Control--functions associated with flying the aircraft (e.g., hovering, maneuvering NOE, and unmasking);
- mission--functions associated with achieving combat objectives (e.g., acquiring and engaging targets); and
- support--functions performed in support of flight control and mission functions (e.g., checking systems and threat warning displays, navigating, and communicating).

Each of the functions was dissected into "performance elements" considered critical to successful performance of the function. Each performance element was analyzed to:

- identify the generic subsystem presenting the primary man/ machine interface,
- estimate the workload imposed on the operator, and
- estimate the length of time required to complete the performance element.

Identification of the generic subsystems was based upon knowledge of the manner in which similar tasks are performed in existing Army helicopters. Workload, as the term was used in these analyses, has three components: sensory, cognitive, and psychomotor. Scales for estimating workload were developed and scale values were assigned to each of the components of workload after all performance elements had been identified. Also, the duration of each performance element was estimated and included in the analysis. Existing helicopter task analyses were used to derive estimates of performance element duration.

The last step in the manual analysis was to review the functions and decide how workload could be reduced by distributing crew functions between two pilots. Flight control functions were assigned to one crewmember, and support and mission functions were assigned to the other crewmember.

The primary objective of the manual analysis was to provide a data base for use in estimating the crew workload demand for different LHX configurations: single versus dual crewmember, and various levels of automation. The generic subsystems, workload estimates, and time estimates provide the desired data base at the performance-element level of specificity.

Work Completed--Computer Analyses

From the start of the manual analyses, plans were formulated for development of computer programs and data files that would enable rapid analysis of various equipment automated options for the LHX crew functions and for comparison of the one- and two-crewmember configurations. Plans called for using the ARI Field Unit's Perkin-Elmer mini computer. FORTRAN 77 was chosen as the program language for the computerization effort.

Work on the computer analyses began on 1 October 1983. The coding strategies, input formats, and computer programming efforts focused on replicating the manual analyses of the one-crewmember, no automation configuration. Inconsistencies in terminology, time, and workload estimates from the manual analyses were resolved and standardized while planning for the data entry programs. Several data files were created as follows:

- a list of verbs and objects,
- a list of performance elements with estimates of workload and time,
- a list of functions,
- a list of segments, and
- a list of subsystem identifiers.

The manual analyses had been developed using a top-down approach, i.e., the analyses started with the identification of the missions and followed, top down, through the phases, segments, and functions to the performance element level. For the computer analyses, a bottom-up approach was adopted, with the performance elements serving as the basic elements of analysis. The time estimates for all of the performance elements were rounded off to the nearest half second and a program was developed to produce a timeline with half-second intervals.

Decision rules were written for building each of the functions from performance elements. Decision rules for discrete performance elements define the sequence in which the performance elements are to be programmed. Continuous performance elements have no definite start and/or completion time and often overlap other performance elements. Decision rules employing probability statements were developed so that performance elements likely to occur at the same time could be presented at alternating half-second intervals in accordance with a designated probability of occurrence. The decision rules also enable performance elements to be introduced at random times.

More complex decision rules were needed to provide the necessary degree of realism in building segments from functions. The general guidelines listed below were followed in formulating the decision rules:

- A flight control function must be present throughout the segment timeline.
- Function duration must be specified in every case.
- If a designated mission or support function cannot be completed during the time period designated for a mission segment, the mission segment (and the flight control function) must be extended for the amount of time needed to complete that mission or support function. The time is extended by selecting a single performance element in the function. (Performance element "Stabilize aircraft" was the performance element chosen most often for the time extension.)
- Flight control functions cannot overlap temporally.
- The onset of all mission and support functions must correspond with the temporal relationships specified on the segment summary worksheet.
- The duration of all support functions and mission functions must correspond with the durations specified on the corresponding function analysis worksheets.
- To the greatest extent possible, the onset of support functions must be adjusted to minimize workload and to avoid generating an overload condition.
- The onset of mission functions must be dictated solely by mission requirements.

The LHX Mission Equipment Package (MEP), provided by DCD, was used as a guide in classifying subsystems and in devising a subsystem coding strategy. In this way, the subsystems identified in the analysis were

loosely tied to the subsystem classification being used in the LHX trade-off analyses. The major categories of subsystems in the MEP are:

- communications,
- navigation,
- flight control,
- target acquisition,
- aircraft survivability equipment (electronic),
- night vision pilotage, and
- controls and displays.

The major classes of subsystems used in the computer analyses are listed below:

- communication (C),
- navigation (N),
- flight control (F),
- fire control (I),
- target acquisition (A),
- aircraft survivability equipment (S),
- display subsystem (D),
- life support system (L),
- personal equipment/cockpit items (P), and
- visual field unaided (V).

The letter shown in parentheses is the first letter of the subsystem identifier code. A second and third letter was added to the first letter as necessary and the subsystem codes were entered in the performance element data file so that they can be readily identified when a performance element contributes to an overload condition.

Computer programs were developed to ensure that (a) the onset and duration of performance elements adhere to the rules established for building functions from performance elements, and (b) the onset and duration of functions adhere to the decision rules established for building mission segments from functions.

Originally, it was estimated that between 75 and 100 programs would be required to computerize the one-crewmember analysis. However, 170 separate programs were required before the computer analysis was completed. Programs provide both an 80-column terminal screen presentation and a 132-column paper printout program. The screen program lists only function numbers, whereas the print program lists the full names of segments, functions, and performance elements.

For the two-crewmember analyses, 220 separate programs were required to complete the computer analysis. The programs provide two 132-column paper printout programs, one is for the pilot and one is for the copilot. No terminal screen programs were written for the two-crewmember analysis.

The one- and two-crewmember computer analyses have been completed. Both a one- and two-crewmember computer model have been produced. Project personnel developed four different indices of the extent of operator workload. The four indices can be tabulated from the computer model in order to compare workload for various configurations of automation options or to compare one- and two-crewmember configurations.

A draft report has been written and is undergoing in-house review at the end of Fiscal Year (FY) 1984. The draft report describes the computer analysis procedure in detail, presents results from a baseline one- and two-crewmember analysis and includes a paper-and-pencil analysis that identifies 28 different automation options required to eliminate operator overload in a one-crewmember configuration and 10 automation options required to eliminate overload in a two-crewmember LHX configuration. The report concludes that the two-crewmember LHX configuration is the preferred option.

Projected Completion Date

Each of the 28 individual options will be exercised using both the one- and two-crewmember models. Moreover, various combinations of the automation options will be exercised. The models will be exercised further in response to questions about how operator workload will be affected by automation options being proposed for the LHX. Such exercises will be scheduled in coordination with DCD human factors specialists who are conducting LHX trade-off analyses. The results of introducing the various automation configurations into the model will be provided to DCD and will be reported in a formal report to the ARI Field Unit at Fort Rucker. Thus, work on the project will continue to 30 November 1984.

Forecast of Additional Work

The computer models and methodology developed in the project may prove valuable throughout the conceptual and developmental phases of the LHX system programs. Two LHX-specific program activities have been identified where additional work may be required:

- A Cost and Training Effectiveness Analysis (CTEA) will be performed subsequent to the trade-off analysis presently being conducted by DCD. The computer models may be used to support the CTEA.
- A representative from the Army's Aviation Systems Command (AVSCOM) has indicated that the model may have utility during the evaluation of proposals from the major contractors who respond to the LHX Request for Proposal (RFP). The computer models may be used to support LHX source selection.

Another area of work currently being considered is LHX system simulation. The estimates of workload and time need validation. Flight simulation will provide a means of refining the workload and time values in the model. Incidents of overload and the impact of subsystem automation can be evaluated by collecting empirical data during trials in a flight simulator. The mission analysis provides a scenario for flight simulation. The estimates of workload, performance times, and incidents of overload provide a host of hypotheses that are testable in flight simulation experiments. During FY 1985, project personnel will prepare a plan for validating the LHX analyses using flight simulation.

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ASSESSMENT OF THE RELATIONSHIP BETWEEN ANTHROPOMETRIC SIZE OF ARMY HELICOPTER PILOTS AND PILOTS' ABILITY TO PERFORM VARIOUS FLIGHT TASKS/MANEUVERS

Dr. Kathleen A. O'Donnell, Project Director

BACKGROUND

The cockpit of an aircraft provides a finite amount of space in which a person must successfully perform all necessary operations. Because the amount of space is finite, minimum and maximum standards of operator body size must exist for operational efficiency, comfort, and injury avoidance. A single measure of size (such as height) is not sufficient for determining whether a person's body size is acceptable for safe and comfortable control of an aircraft. For example, it is possible that a person will meet the minimum height requirement for an aircraft, but not have the leg or arm length necessary to accomplish full control movements in the aircraft. This possibility led to a change in the standards required for entry into the Army flight training program.

In May 1980, the Surgeon General's Office issued a change to the Medical Fitness Standards for Flying Duty Classes. This change replaced the minimum height criterion of 64 inches with the following anthropometric standards:

- 68 to 76 inches in height, or
- less than 68 inches in height with a minimum leg length (LL) of 70.75 cm and a combined measure of sitting height (SH) and functional arm reach (FAR) of 150.5 cm.

These standards were developed by the Human Engineering Laboratory (HEL) and the U.S. Army Aeromedical Research Laboratory (USAARL). They are based on static measurements taken in aircraft mockups and in stationary aircraft cockpits of the UH-1, OH-58, and AH-1 aircraft.

NEED/PROBLEM

The alteration of flight school selection standards was based on the minimum anthropometric measurements necessary to manipulate aircraft

controls in a static situation. In addition, the minimum acceptable measurements were assessed separately for each control. There is a need to ensure that the new selection standards are adequate when the subject is placed in a dynamic situation (i.e., a flight situation in which the controls must be integrated).

PROJECT OBJECTIVE

The specific objective of this project was to ensure that student aviators who meet the new Army anthropometric standards are capable of operating all Army aircraft.

RESEARCH APPROACH

Subjects

Subjects were Commissioned Officers (COs) and Warrant Officer Candidates (WOCs) in the Army's Initial Entry Rotary Wing (IERW) Flight Training Course and the AH-1 Aviator Qualification Course during calendar years 1980, 1981, 1982, and 1983. Subjects were divided into three groups. The short group included all IERW students with a height of 64 inches and below or with anthropometric measurements less than the following: 74.8 cm for LL, 158.9 cm for combined SH and FAR (SH + FAR). The control group included a random sample of IERW students with a height between 64.1 inches and 72.9 inches or with anthropometric measurements between the following: 74.8 and 89.3 cm for LL, 158.9 and 182.9 + SH and FAR. The tall group consisted of a random sample of IERW students with a height of 73 inches and above or with anthropometric measurements greater than the following: 89.3 cm for LL, 182.9 for SH + FAR.

A group of IPs were asked to identify any aircraft maneuvers and/or procedures on which short or tall students would be likely to experience difficulty due to their size. In addition, they were asked to provide an hour-level range, for each maneuver, within which poor performance might indicate a special difficulty. This was accomplished for three different aircraft--the TH-55, the UH-1, and the AH-1.

Three performance measures were used:

- daily grades on 26 maneuvers: six for the TH-55, four for the UH-1, and six for the AH-1;
- elimination from the IERW Flight Training Course; and
- setbacks received during the IERW Flight Training Course.

Repeated measure ANCOVAs were performed on the daily grade data and tests of proportions were performed on the elimination and setback data. Age and ability were used as covariates.

RESULTS

The results indicate that aviator size does not affect flight performance in the Army rotary wing flight training program. No statistically significant differences in flight performance were found among the three size groups (short, control, tall). Aviator size also does not have a significant effect on elimination from the flight training program. Although a statistically significant difference was found between the proportion of tall students with setbacks and the proportion of control students with setbacks (for total setbacks and flight deficiency setbacks), the difference was in favor of the tall students rather than showing a deficiency due to excessive height.

PROJECT STATUS

All work on this project has been completed. A final report on the work was submitted to ARI in June 1984.

DEVELOPMENT OF A VIDEODISC VERSION OF THE BASIC MAP INTERPRETATION AND TERRAIN ANALYSIS COURSE (MITAC)

Mr. Claude O. Miles, Project Director

BACKGROUND

During NOE flight, an aviator flies at varying speeds as close as possible to the earth's surface--preferably flying around obstacles instead of over them--to escape radar or optical detection by a potential enemy. Visual pilotage is extremely important in maneuvering the aircraft and in maintaining geographical orientation. This is a requisite skill that requires specialized training (Fineberg, Meister, & Farrell, 1978). The need for this type of training stems from navigational problems uniquely associated with NOE flight, including:

- the limited forward view when operating in close proximity to the ground,
- the perspective from which checkpoints are viewed,
- the difference in perspective between the map representation and the point of regard of the NOE navigator,
- the need for more precise geographic orientation, and
- the requirement for rapid association of map features with their real-world counterpart.

Tests have shown that checkpoint identification--the most critical factor to successful mission planning--appears to be the primary and most critical error made in NOE navigation. Tests also indicate that experience from flight at higher altitude does not necessarily transfer well to NOE navigation. Therefore, specialized training is needed to ensure proficiency in NOE navigation (Fineberg, Meister, & Farrell, 1978). In response to this need, the Army Research Institute (ARI) developed and implemented a system for training Army aviators the critical skills necessary to navigate successfully at NOE altitudes in a high threat environment. This course was named the Map Interpretation and Terrain Analysis Course (MITAC). The course teaches the students the cartographic rules and practices used to compile 1:50,000-scale topographic maps and teaches them to associate the full range of map symbols portrayed on the map with the real-world features they

represent. Also, navigation exercises teach student aviators to employ their knowledge of map interpretation to maintain geographic orientation while flying filmed NOE routes in a variety of different topography.

The Basic MITAC is presented in 13 instructional units. The course begins with lessons designed to teach students the basic principles of cartography and map interpretation and continues through more complex training exercises on checkpoint selection and progressively more complex navigation exercises. A series of color 35-mm slides are provided for use in teaching the principles of feature selection, classification, and encodement followed in compiling 1:50,000-scale topographic maps. A special text entitled "Map Interpretation in NOE Flight" is also provided to supplement the course material. The features discussed in both the text and the illustrated lectures include:

- hydrography,
- vegetation,
- transportation lines,
- buildings, and
- miscellaneous cultural features.

A narration recorded on cassette tapes is provided to supplement the slides. In this portion of the program, the student is taught:

- the basis for the classification of roads,
- the coding criteria for vegetation cover,
- the practices used in delineating relief and drainage,
- the conventions used when portraying cultural features, and
- generalization and displacement practices in cartographic drafting (Cross & Rugge, 1980).

The performance-oriented exercises emphasize analysis of terrain features and their representation on the map. The exercise requires students to conduct NOE mission planning, to identify checkpoints, and to assess terrain masking. A scenario is provided by means of cinematic simulation in which the students experience the practical application of the principles they are taught. The exercises begin with a preflight briefing; then, the student performs a navigation exercise and listens to a prerecorded debriefing commentary. The exercises require the students to maintain geographic orientation and to mark checkpoints on a

map while viewing a motion picture film of routes flown at NOE. The exercises include:

- a contour analysis exercise,
- preflight terrain analysis exercises,
- along-track orientation exercises,
- cross-track orientation exercises, and
- corridor orientation exercises.

The Basic MITAC was evaluated at USAAVNC and found to be effective in teaching the skills required for NOE navigation (Holman, 1978). The Basic MITAC is presently being used at the U.S. Army Aviation Center (USAAVNC) for NOE training of Initial Entry Rotary Wing (IERW) students. A study revealed that a group of IERW students trained with Basic MITAC navigated NOE routes with twice the speed and one-third the errors of an equivalent group of conventionally trained IERW students. It was also shown to be an effective training program for use in Europe, based on the evaluation of its use in Germany.

NEED/PROBLEM

The objective of this effort is to expand and improve the quality of the original course materials and provide a more effective and sophisticated medium through which to present the materials. In September 1983, ARI requested that the basic MITAC course be refined and converted to an interactive videodisc format.

RESEARCH APPROACH

Preparation for the conversion of this project began with an intensive review of the literature on interactive videodisc technology, as well as attending training workshops held in Atlanta, Georgia, and Fort Rucker, Alabama. Information concerning the development of interactive videodisc training materials was obtained and reviewed to determine the capabilities the systems possess and how they might best be utilized to suit the needs of this particular type of training. The Sony videodisc system was chosen by ARI and ASI for the project.

The illustrated lectures for infantrymen (Cross & Rugge, 1980) are being used as a guide in developing a comprehensive series of illustrated lectures for basic MITAC. The illustrated lectures are to be edited and rewritten, making them applicable for Army aviators. The lectures are to include in-depth sections on hydrography, vegetation, transportation lines, buildings and miscellaneous cultural features. Quiz questions and remedial feedback are being written to test and reinforce a student's understanding and retention of information presented in the exercises. The course also has programmer support during the various stages of development. The programmer will assist in the flow charting and branching processes necessary for development of the project.

An exhaustive set of slides needed to support the commentaries is being compiled. Some of the necessary slides have been taken and additional photo missions are being planned.

PROJECT STATUS

Due to the simultaneous conversion of the Advanced MITAC series to videodisc, much time had to be allocated to that project. However, progress continues in the revision process and preparatory procedures for the conversion of the Basic MITAC to interactive videodisc. The expected date of completion for this project is September 1985.

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AN EXAMINATION OF ABILITY REQUIREMENTS FOR VARIOUS ROTARY WING MISSIONS

Dr. Dennis H. Jones, Project Director and Mr. D. Michael McAnulty

BACKGROUND

The increasing specialization of rotary wing missions and aircraft has precipitated a reanalysis of traditional strategies for assigning student aviators to one of four rotary wing missions: cargo, utility, aeroscout, or attack. Current assignment strategies are based on extensive anecdotal evidence that suggests there are substantial differences in the ability requirements for the four missions. Specifically, the anecdotal evidence suggests that successful aeroscout and attack aviators require more of the "right stuff" than aviators in the other two missions. In view of this, the U. S. Army Research Institute (ARI) Field Unit at Fort Rucker, Alabama has sponsored two research efforts (Miller, Eschenbrenner, Marco, & Dohme, 1981; Myers, Jennings, & Fleishman, 1982) to determine the feasibility of a classification system based on differences in the ability requirements of the four missions. Although each research effort provides unique insight into the types of abilities required for each type of mission, their analyses did not include direct comparisons of ability requirements among the missions. In order for a classification system based on ability requirements to be feasible, it must be established, a priori, that statistically significant differences exist between the four missions.

PROJECT OBJECTIVE

The objective of this project is to reanalyze the data collected by Myers et al. (1982) to determine whether a classification battery based on differences in ability requirements should be developed and used to assign student aviators to one of the four rotary wing missions. The specific goals of this project are as follows:

- to evaluate the psychometric errors in the raters' distributions and, if necessary, transform the data;
- to identify the ability requirements for each of the four rotary wing missions;

- to compare the ability requirements; and
- to make recommendations about the utility of a classification system based on ability requirements.

RESEARCH APPROACH

The following sections describe the subjects and procedures used by Myers et al. (1982) in the original research design.

Subject Matter Experts (SMEs)

The SMEs were all rated aviators with advanced training in their aircraft mission specialty. There were 11 SMEs for the cargo mission, 16 SMEs for the utility mission, 17 SMEs for the aeroscout mission, and 16 SMEs for the attack mission.

Procedure

Myers et al. had each SME rate the importance of each of 32 abilities (see Table 1) on a set of previously selected mission tasks. Each mission had an independent task list, and the SMEs rated only those tasks for the mission for which they specialized. There were 10 tasks rated for the cargo mission, 15 tasks rated for the aeroscout and utility missions, and 20 tasks rated for the attack mission. There were three tasks common to all four missions: perform NOE (nap-of-the-earth) flight, perform tactical operations in an NBC (nuclear, biological, chemical) environment, and identify US/Allied threat weapons and aircraft.

SMEs independently rated the importance of each task using the Ability Requirements Scale (ARS) developed by Fleishman and his colleagues (Theologus, Romashko, & Fleishman, 1973; Fleishman, 1975). An ARS value ranges from 1, representing the lowest level of an ability, to 7, representing the highest level of an ability. Benchmark tasks placed at various points on the scale indicate the level of an ability associated with selected scale values (e.g., see Jones & McAnulty, 1984). In addition, each ARS form presents a concise definition of the

ability and an explanation of how the ability of interest differs from other similar abilities. The ability rating approach has been shown to be effective in providing a reasonably valid set of descriptions for characterizing individual jobs or tasks (Fleishman & Hogan, 1978; Myers, Gebhardt, & Fleishman, 1979).

TABLE 1

ABILITIES SELECTED BY MYERS ET AL. (1982) FOR JOB ANALYSIS

	ABILITY FAMILY	ABILITY	ABILITY CODES
1.	LANGUAGE	WRITTEN EXPRESSION	WRIT EXP
2.	LANGUAGE	WRITTEN COMPREHENSION	WRIT COM
3.	LANGUAGE	ORAL EXPRESSION	ORAL EXP
4.	LANGUAGE	ORAL COMPREHENSION	ORAL COM
5.	PERCEPTUAL	PERCEPTUAL SPEED	PERC SPD
6.	PERCEPTUAL	VISUALIZATION	VISUALIZ
7.	PERCEPTUAL	SPATIAL ORIENTATION	SP ORIEN
8.	PERCEPTUAL	TIME SHARING	TIME SHR
9.	PERCEPTUAL	SELECTIVE ATTENTION	SEL ATTN
10.	PERCEPTUAL	FLEXIBILITY OF CLOSURE	FLX CLOS
11.	PERCEPTUAL	SPEED OF CLOSURE	SPD CLOS
12.	PSYCHOMOTOR	REACTION TIME	REACT TM
13.	PSYCHOMOTOR	CHOICE REACTION TIME	CHOICERT
14.	PSYCHOMOTOR	MULTILIMB COORDINATION	ML COORD
15.	PSYCHOMOTOR	CONTROL PRECISION	CTL PREC
16.	PSYCHOMOTOR	MOVEMENT/POSITION MEMORY	POSN MEM
17.	PSYCHOMOTOR	RATE CONTROL	RATE CTL
18.	PSYCHOMOTOR	ARM-HAND STEADINESS	A-H STDY
19.	PSYCHOMOTOR	FINGER DEXTERITY	FING DEX
20.	PSYCHOMOTOR	SPEED OF LIMB MOVEMENT	SPD LIMB
21.	PSYCHOMOTOR	WRIST-FINGER SPEED	WF SPEED
22.	COGNITIVE	MEMORIZATION	MEMORIZN
23.	COGNITIVE	DECISION MAKING	DEC MAKG
24.	COGNITIVE	INFORMATION ORDERING	INFO ORD
25.	COGNITIVE	CATEGORY FLEXIBILITY	CAT FLEX
26.	COGNITIVE	NUMBER FACILITY	NUMB FAC
27.	COGNITIVE	PROBLEM SENSITIVITY	PROB SEN
28.	COGNITIVE	DEDUCTIVE REASONING	DED REAS
29.	COGNITIVE	INDUCTIVE REASONING	IND REAS
30.	COGNITIVE	ORIGINALITY	ORIGINAL
31.	COGNITIVE	FLUENCY OF IDEAS	IDEA FLU
32.	COGNITIVE	STRESS TOLERANCE	STRS TOL

Replacing Missing Data

The first task was to locate and replace all missing data using an abilities by raters matrix for each task. Each of the 104 missing ratings was replaced with the mean of the other raters. One rater from the cargo mission and two raters from the attack mission failed to rate the 32 abilities on one task. The remaining eight missing ratings were scattered across the missions.

PROJECT STATUS

Work Completed

Psychometric evaluation of ratings. Research by McAnulty and Jones (1984) found that ARS ratings exhibited distributional anomalies that were analagous to bias effects frequently encountered in performance appraisal ratings (e.g., Saal, Downey, & Lahey, 1980). McAnulty and Jones concluded that the ratings represented only an ordinal level of measurement despite the presence of an anchored, equal interval scale. The same pattern of results were found in the ARS ratings of the mission tasks. There were substantial differences in rater means and variances, and heterogeneity in the shapes of the rating distributions. These results indicate individual differences in rater leniency/severity and range restriction.

Another technique used to assess psychometric rating errors is factor analysis. Ratings that are lacking in discriminant validity (affected by halo errors) are indicated by (a) high intercorrelations among the rating dimensions, and (b) a general factor that accounts for a substantial proportion of the variance (Landy, Vance, Barnes-Farrell, & Steele, 1980). Both of these conditions were evident in the ability ratings in each mission. For example, Table 2 presents the results of a maximum-likelihood factor analysis (MLFA) with varimax rotation for the utility mission. The results indicate a four-factor solution, with the first factor, a general ability factor, accounting for 45% of the variance. The other three factors, comprised of cognitive, perceptual-language, and psychomotor abilities, respectively, accounted for only 19% of the remaining variance.

TABLE 2

FACTOR ANALYSIS OF ABILITY RATINGS
FOR UTILITY MISSION (ORIGINAL DATA)

GENERAL ABILITY FACTOR 1	COGNITIVE FACTOR 2	PERCEPTUAL LANGUAGE FACTOR 3	PSYCHOMOTOR FACTOR 4
RATE CTL (.76)	MEMORIZN (.73)	ORAL COM (.76)	SPD LIMB (.82)
SP ORIEN (.73)	CAT FLEX (.72)	WRIT COM (.73)	CTL PREC (.65)
POSN MEM (.69)	INFO ORD (.70)	ORAL EXP (.67)	A-H STDY (.58)
REACT TM (.6[illegible]	NUMB FAC (.65)	WRIT EXP (.63)	
CHOICERT [illegible]	DED REAS (.64)	SPD CLOS (.57)	
TIME SHR [illegible]	ORIGINAL (.63)	SEL ATTN (.54)	
IND REAS (.58)	DEC MAKG (.58)	FLX CLOS (.53)	
STRS TOL (.57)			
CUMULATIVE PROPORTION OF TOTAL VARIANCE .45	.53	.59	.64

Note. Numbers in parentheses indicate factor loadings. Criterion for entry = .50 or higher.

These analyses indicate that the mission ability ratings are significantly affected by systematic rater bias that restricts the interpretability of the ratings. Previous research (McAnulty & Jones, 1984) found that a transform to normalize the rating distributions was an effective technique for removing systematic sources of error without distorting the task-ability relationships.

Transformation of original data. The original data were transformed using the Method of Successive Intervals (MSI) technique (Guilford, 1954; Hays, 1967; McAnulty & Jones, 1984). The MSI technique transforms each rater's judgments to a normally distributed, standardized scale having a mean of zero and a standard deviation of approximately one. The method uses the cumulative proportion of ratings in each successive scale interval and the area under the normal curve to convert raw scores into $\underline{z}$ scores. The $\underline{z}$ scores for each rater were then added to the grand mean of the original data for each rater's mission (cargo = 3.38; utility = 3.57; aeroscout = 3.11; attack = 3.34).

The effectiveness of the transform can be seen in Table 3. The results of the MLFA with a varimax rotation on the transformed data indicate that systematic error has been reduced. Specifically, the results show that the general ability factor has disappeared and has been replaced by more specific factors. In addition, the variance accounted for is much more evenly spread among the factors. These findings were consistent for each of the four missions. That is, in each mission, except the attack mission, there was a general ability factor in the original data that disappeared and was replaced by more specific factors following the transformation (see Jones & McAnulty, 1984).

Taken together, these findings are interpreted as further evidence of the utility of the MSI technique for reducing systematic error in rating data. Furthermore, and perhaps most important, the ability requirements for the various rotary wing missions can be interpreted and treated statistically as interval level data.

TABLE 3

FACTOR ANALYSIS OF ABILITY RATINGS FOR UTILITY MISSION (TRANSFORMED DATA)

PSYCHOMOTOR FACTOR 1	PERCEPTUAL FACTOR 2	COGNITIVE FACTOR 3	COGNITIVE FACTOR 4	WRITTEN COMMUNICATION FACTOR 5
ML COORD (.85)	PERC SPD (.70)	IND REAS (.61)	MEMORIZN (.77)	WRIT EXP (.86)
CTL PREC (.82)	SEL ATTN (.69)	CAT FLEX (.58)	NUMB FAC (.66)	WRIT COM (.65)
POSN MEM (.79)	SPD CLOS (.67)	ORIGINAL (.57)	CHOICERT (.51)	
SPD LIMB (.70)	ORAL COM (.65)	IDEA FLU (.53)	INFO ORD (.51)	
A-H STDY (.68)	TIME SHR (.62)	DED REAS (.51)		
RATE CTL (.67)	SP ORIEN (.62)			
WF SPEED (.65)	FLX CLOS (.62)			
STRS TOL (.59)	VISUALIZ (.58)			
REACT TM (.56)	ORAL EXP (.51)			
CUMULATIVE PROPORTION OF TOTAL VARIANCE .34	.45	.52	.56	.59

Note. Numbers in parentheses indicate factor loadings. Criterion for entry = .50 or higher.

Comparing ability requirements. Three analyses were conducted to compare the ability requirements among the missions. Each analysis utilized analysis of variance techniques to determine whether there was a significant mission by abilities interaction effect. It is the interaction effect that provides relevant information about differences in ability requirements among the missions. Readers interested in the main effects should see Jones & McAnulty (1984) for a much more detailed report of these analyses. In the first analysis, the rating data for each mission were collapsed across tasks and a three-way ANOVA was performed. The results indicated that there was a significant ability by mission interaction effect. However, the interaction effect accounted for less than three percent of the variance. Furthermore, reducing the rating data by collapsing across tasks in each mission is appropriate only if there is no significant ability-by-task interaction effect within each mission. An ability by task by rater three-way ANOVA was conducted for each mission and, in each case, the ability by task interaction was significant. This finding indicates that a comparison of ability requirements by averaging across tasks may lead to erroneous conclusions about differences or similarities among the missions.

The second analysis was a comparison of ability requirements for the three common tasks. The results indicated that there was a significant ability by mission interaction effect, but this effect accounted for less than one percent of the variance. Furthermore, this finding has limited generalizability since there is no way to be certain that the three common tasks impose the maximum ability requirements on the aviators.

The third ANOVA was conducted using ability ratings representing the highest rating across tasks. An ability by task matrix was developed and, for each ability, the highest rated task was selected to represent the ability. This procedure is intuitively appealing: if an aviator possesses a sufficient amount of ability to perform the most demanding task, the aviator must possess a sufficient amount of the ability to perform all critical mission tasks. A classification algorithm based on ability requirements should classify the student aviator

by ensuring, statistically, that the minimum amount of each ability possessed by the student is equal to or greater than the maximum amount of the same ability required to perform <u>all</u> tasks within the mission to which the aviator will be assigned. Furthermore, even though only one task within a mission requires a substantial amount of a certain ability, it is the ability requirement associated with that one task that establishes the minimum ability requirement for the mission.

The results of the mission by abilities by raters ANOVA using the highest mean ability rating across tasks are shown in Table 4. The absence of a significant interaction effect indicates that there are no significant differences in abilities required for the four rotary wing missions.

TABLE 4

SUMMARY OF THE MISSION X ABILITY X RATER ANALYSIS OF VARIANCE OF THE HIGHEST MEAN ABILITY RATING ACROSS TASKS (TRANSFORMED DATA)

SOURCE	DF	MS	$\underline{F}$
MISSION (M)	3	7.87	NT
ABILITIES (A)	31	12.50	21.00*
MA	93	.71	1.19
RATERS (R)	53	1.78	--
MAR	1643	.60	--
TOTAL	1824		

*p <.01

Recommendations. Taken together, these analyses indicate that there is a high degree of similarity in ability requirements among the four missions. Although certain missions may consistently require a higher level of certain abilities, these results indicate that, across missions, there are substantial similarities in the magnitude of abilities and types of abilities required to perform the most demanding tasks. These results suggest that a classification system based on ability requirements could be expected to be no more successful than an assignment system that equally distributes the aviators (by ability)

across the four missions. However, it is possible that differences in ability requirements among the missions do exist and that a classification system based on ability differences is a viable alternative. As suggested elsewhere (Jones & McAnulty, 1984), there are serious methodological problems in the research by Myers, et al. (1982) that may have precluded the identification of ability differences. For example, Myers, et al. selected tasks identified by the Aircrew Training Manual (ATM) for each mission and required SMEs to rate the abilities for a subset of these ATM "tasks." It is quite possible that substantially different ability profiles for each mission could be identified if the SMEs were required to rate specific tasks rather than broad, ambiguous ATM "tasks" such as "perform tactical operations in an NBC environment."

Project Completion Date

A report entitled "An Examination of the Ability Requirements for Various Rotary Wing Missions" (Jones & McAnulty, 1984) has been forwarded to ARI for review. Decisions about further work on this project will be made at a later date.

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EVALUATION OF A FLIGHT SURGEON COURSE SYLLABUS CHANGE

Mr. D. Michael McAnulty, Project Director

BACKGROUND

In November 1983, the Directorate of Flight Training (DOFT) revised the syllabus for the Flight Surgeon training program by deleting the solo flight and substituting a formal checkride evaluation at the 14-hour flight level. The revision was designed as a preventive safety measure: there had recently been a dramatic increase in the frequency of engine failures in the training helicopter (TH-55) fleet and a Flight Surgeon student had recently experienced an accident during his solo flight. However, the Army Aeromedical Activity (AAMA) contended that the syllabus change could be detrimental to the Flight Surgeon program. As a result, DOFT implemented the syllabus change on a one-year trial basis and included the U.S. Military Academy (USMA) and the Army Reserve Officer Training Corps (ROTC) Cadet Summer Training programs in the trial revision. Subsequently, DOFT requested that the Army Research Institute (ARI) assist in evaluating the effects of the Flight Surgeon Course syllabus change during the trial year.

OBJECTIVES

A preliminary investigation was conducted by collecting and analyzing previous Flight Surgeon training records and TH-55 helicopter performance, and by interviewing representatives of AAMA, the Army Safety Center, the Aviation Medicine Department, the Office of Accident Prevention (OAP), and Aviation Contract Employees, Inc. (ACE). (ACE conducts the Flight Surgeon and Cadet Summer Training programs.) The conclusion drawn from the investigation was that, although the degree of risk is relatively small, a solo flight is an unnecessarily hazardous requirement for Flight Surgeons unless the syllabus change results in negative effects on the training programs. The investigation identified three areas of potential negative impact. The evaluation of these three areas constitutes the technical objectives of the project:

- evaluate the effect of the syllabus change on the recruitment of Flight Surgeons,
- evaluate the effect of the syllabus change on the attitude and performance of the Flight Surgeons during training, and
- evaluate the effect of the syllabus change on the professional performance of the Flight Surgeons.

RESEARCH APPROACH

In January 1984, DOFT conducted an in-process review (IPR) with representatives of AAMA, ACE, OAP, ARI, and the Directorate of Evaluation and Standardization. At that meeting, an evaluation approach was submitted for each of the specific objectives. First, an "Incentive Factors Survey" was developed to address the recruitment issue. The survey requires the Flight Surgeons to rate the importance of several factors, including the opportunity to fly solo, on their decision to apply for the Flight Surgeon Program. The Incentive Factors Survey approach was approved by the Director of DOFT who requested that the survey also be adapted for the USMA and ROTC classes.

Two approaches were proposed to assess the performance of the Flight Surgeons during flight training. First, routine evaluation records would be reviewed to determine their utility for comparing Flight Surgeon performance under the solo and checkride training criteria. Second, a "Flight Training Survey" would be developed to obtain instructor pilot (IP) ratings of Flight Surgeon performance, ability, attitude, and motivation during training. Both approaches were approved for the Flight Surgeon Course.

Finally, a "Critical Incident Survey" was proposed to assess the effect of the syllabus change on professional performance. The survey would be administered to experienced Flight Surgeons attending an advanced training course at Fort Rucker. The Flight Surgeons would be asked to identify specific incidents in which their solo (or lack of solo) experience affected their professional performance. The Director of DOFT requested further development and evaluation of this approach before granting approval.

PROJECT STATUS

Recruitment Evaluation

Three "Incentive Factors Survey" forms have been developed to assess the relative importance of the major recruitment incentives in each student's decision to apply for flight training. The students are required to distribute 100 points among the factors that positively influenced their decisions. The survey was first administered to Flight Surgeon Class 84-2 in February 1984. The opportunity to fly solo had a mean rating of 10.6 points, but there was substantial variability in the ratings. Approximately 40% of the class rated solo flight as a neutral or negative factor, 33% rated it as a moderately positive factor (1-15 points), and 27% rated it as a strongly positive factor (20-40 points). The results of the survey were documented in an internal memorandum (McAnulty, 1984) submitted to ARI.

The "Incentive Factors Survey" has subsequently been administered to Flight Surgeon Class 84-3, USMA Classes 84-1 and 84-2, and ROTC Class 84-3. The solo flight ratings have been similar for each administration: solo flight was an important incentive to some class members but was unimportant or only slightly important to the majority of each class.

Training Performance Evaluation

The course grade folders for Flight Surgeon Class 83-3 were obtained and the daily grades for attitude, motivation, and overall performance were evaluated as potential training criteria. The psychometric characteristics of the grades were not indicative of reliable and valid measurement. The solo flight was relatively independent of training performance ratings and the attitude and motivation ratings were homogeneous and inflated. The routine records were not considered adequate as criteria for evaluating the syllabus change.

A "Flight Training Survey" form was developed to obtain IP ratings of each student's attitude, motivation, ability, and performance during flight training. The IPs are asked to rate the average level of each

attribute and the direction and degree of change, if any, in the attributes during training. Finally, the IPs are asked to describe any attitudinal or performance effects that could be attributed to the syllabus change. The survey was administered to the IPs of Flight Surgeon Class 84-2. The majority of the Flight Surgeons were rated as having a positive attitude, being highly motivated, and performing at a level that was commensurate with their ability. There were exceptions, but these were either not attributable to the syllabus change or did not result in a negative training effect. The results of the survey were documented in an internal memorandum (McAnulty & Millard, 1984) submitted to ARI.

Professional Performance Evaluation

Further development and evaluation of the critical incidents approach led to the conclusion that it is not feasible to evaluate the effects of the syllabus change on professional performance. This decision was based on the multiplicity of factors that influence professional performance and the lack of an absolute requirement for solo flight under the previous syllabus (i.e., nearly half the Flight Surgeons did not solo). With the concurrence of AAMA, further evaluation of professional performance effects will not be attempted.

Projected Completion Date

Additional incentive factors and flight training data will be collected from Flight Surgeon Classes 84-3 and 85-1 in September and October 1984. These data will be analyzed and a final report will be prepared by December 1984.

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EFFECTS OF EXPANDING THE UH60FS PORTION OF THE UH-60A AIRCREW QUALIFICATION COURSE

Dr. George L. Kaempf, Project Director

BACKGROUND

The Army has recently expressed concern about the dramatic rise during FY84 in the number of mishaps involving the UH-60A aircraft. Through 15 March 1984, the UH-60A had the highest Class A (as defined by Department of the Army, 1984a, p. 5) mishap rate of any helicopter in the Army's inventory (11.02 accidents per 100,000 flying hours). In contrast, the UH-60A mishap rate was only 4.81 for FY83 (Department of the Army, 1984b). Ten of the 19 Class A and B mishaps have been attributed to pilot error.

For this reason, the Department of Aviation Subjects (DOAS) recognized a need for improved training effectiveness during the transition phase of UH-60A pilot training. It was concluded that this improvement could possibly be achieved through a number of methods, including: expansion of the academic training, flight simulator training, and aircraft flight training. Furthermore, DOAS was directed by the Commanding General (CG) of the U.S. Army Aviation Center (USAAVNC) to increase the utilization rate of the UH-60 flight simulator (UH60FS), which is currently maintained at 55% of the total time the UH60FS is available for training. DOAS chose to address both of these issues by proposing an increase in the flight simulator portion of the UH-60A AQC from 7.5 hours to 13.5 hours for each student. The present study was initiated to determine the feasibility and effectiveness of this increase in the amount of simulator training during the UH-60A AQC.

Currently the UH-60A AQC is an 18-day course composed of academic classwork, 7.5 hours in the UH60FS, 7.6 hours of flight training in the UH-60A aircraft, and a 1.4-hour end-of-course checkride in the UH-60A. The first six training days (TD) are devoted exclusively to academics. Flight simulator and aircraft training periods are intermixed from TD 7 through TD 15; the last three days of the course are reserved for aircraft training and the checkride.

Until this research was initiated, the UH60FS was used strictly as an instrument and procedures trainer. During the first training period in the UH60FS, students learned cockpit procedures (runup and shutdown). During subsequent simulator sessions, emergency procedures and instrument flight tasks were taught. Contact flight skills were taught only in the UH-60A.

PROJECT OBJECTIVES

The objectives of this project were to:

- determine the effects of an extended training program in the UH60FS on the level of proficiency and rate of acquisition of flight skills in the UH-60A,
- determine if contact flight skills could be effectively taught in the UH60FS, and
- determine the rates of learning for specific tasks trained in the UH60FS.

RESEARCH APPROACH

A field experiment conducted at the USAAVNC, Fort Rucker, was designed to meet the project objectives. Sixteen students attending UH-60A AQC Class 84-11 served as subjects and were randomly assigned to one of two groups (N = 8/group). The control group was instructed in accordance with the current program of instruction (POI) for the UH-60A AQC. The experimental group received 6.0 hours of training in the UH60FS in addition to the 7.5 hours of flight simulator training normally received during the UH-60A AQC. Otherwise, the training administered to the experimental group and control group was the same. The additional six simulator hours were broken down into four 1.5-hour periods administered between TD 2 and TD 5, during which the experimental group received instruction on contact flight skills. Table 1 presents the POI used to train the experimental group during the UH-60 AQC. The topics identified under periods 2, 3, 4, and 9 constitute the six additional hours of simulator training. However, both groups received instruction in the UH60FS on the topics identified under the remaining periods.

TABLE 1

PROGRAM OF INSTRUCTION FOR UH60FS[1]

FS PERIOD 1	Perform before takeoff checks (1502) Perform engine start and run-up procedures Perform emergency procedures for APU malfunction Perform aircraft shutdown
FS PERIOD 2	Review previous period Use performance charts (1004) Prepare PPC (1005) Perform before takeoff checks (1502) Perform ground-taxi (1506) Perform takeoff to a hover (2001) Perform hover (power) checks (2002) Perform hovering turns (2003) Perform hovering flight (2004) Perform landing from a hover (2005) Perform normal takeoff (2501) Perform traffic pattern flight (3005) Perform before landing checks (3501) Perform VMC approach (3503) Perform after-landing checks (6501)
FS PERIOD 3	Review previous period Perform simulated maximum performance takeoff (2502) Perform roll-on landing (3507) Perform standard autorotation (4002)
FS PERIOD 4	Perform straight and level flight (3001) Perform climbs and descents (3002) Perform turns (3003) Perform deceleration/acceleration (3004) Perform fuel management procedures (3006) Perform navigation by pilotage and dead reckoning (3010) Perform go-around (3506) Perform high reconnaissance (3509) Perform confined area operation (3510) Perform pinnacle/ridgeline operations (3512) Perform flight with degraded AFCS off (4021)
FS PERIOD 5	Perform instrument takeoff (4501) Perform radio navigation (4503) Perform holding procedures (4504) Perform unusual attitudes (4505) Perform NAVAID approach (4508) Perform VHIRP (4510)
FS PERIOD 6	Perform CIS operations (4517) (VOR, NDB, ILS)
FS PERIOD 7	Perform CIS operations (4517) (Mission)
FS PERIOD 8	Perform simulated hydraulic malfunction (4005) Perform simulated antitorque system malfunction (4006) Describe or perform emergency procedures (4010) Perform ECU malfunction (4002) Perform single engine roll-on (4023) Perform stabilator malfunction (4024)
FS PERIOD 9	Review previous period

[1]Numbers in parentheses refer to task designations in TC 1-138.

Four rated Army aviators served as data collectors/observers for this study. The data collectors accompanied students on their training flights in both the UH-60A and UH60FS; they recorded the number of practice iterations each subject completed for each task, the length of time spent executing each practice iteration, and the instructor pilot's (IP) subjective rating of the student's performance on each practice iteration. The IPs employed a seven-point subject rating scale (see Wick et al., 1984) anchored to standards established by the Aircrew Training Manual TC 1-138 (Department of the Army, 1981) to provide an assessment of student performance on each practice iteration.

RESULTS

Initially, a traditional transfer-of-training approach was planned for this study, using the training time and number of practice iterations required to reach a specific criterion level of performance in the aircraft as dependent measures. The performance criterion established was two successive practice iterations of a task rated by the IP as meeting all ATM standards (score of 6 or above). However, as the data indicate, few aviators met or exceeded the criterion for proficiency on as many as half of the tasks; and, in only one instance (experimental group performing emergency procedures in the flight simulator) did the mean rating for a group exceed criterion. In fact, the group means reached a level of 6 or more on only 8 of 35 tasks.

The failure of both the experimental and control groups to reach the criterion level of flight proficiency required that the criterion-based measures of performance be abandoned in favor of measures that more adequately described the subjects' progress through the course. Therefore, IP ratings of each iteration, the number of practice iterations completed, and the total amount of time each subject spent practicing each task were analyzed to determine the effects of extending the flight simulator portion of AQC training.

The IP ratings of performance were analyzed with a separate mixed-design, two-factor analysis of variance (ANOVA; group x practice

iterations) for each task, with repeated measures on the practice iteration factor. The results of these analyses reveal significant practice effects for 16 tasks, where increased numbers of practice iterations resulted in improved performance by the subjects. There was also a significant difference in performance between the experimental and control groups on five of the tasks, including: the final leg of traffic patterns, holding patterns, ECU and stabilator malfunctions, and emergency procedures performed in the UH60FS. On all five tasks, the ratings for the experimental group were significantly higher than ratings for the control group.

The times spent performing each iteration were summed to produce a total amount of time each subject spent practicing each task. These totals include all iterations completed and were submitted to individual _t_-tests for matched pairs for each task. Significant differences were found for only two tasks. The experimental subjects practiced radio navigation in the UH60FS longer than the control subjects and the control subjects spent significantly more time practicing stabilator malfunctions in the aircraft than experimental subjects.

Analysis of the total number of practice iterations for each task practiced by both groups in the UH-60A and the UH60FS indicate that the experimental group completed more practice iterations in the UH-60A on 24 of 36 tasks and on 10 of 13 tasks in the UH60FS. The experimental group completed approximately 10% more practice iterations in the aircraft and 30% more practice iterations in the flight simulator than the control group. These data may be interpreted as reflecting the instructors' judgments that the experimental group required more practice to correct performance deficits; however, IP performance ratings provide no evidence to support this interpretation. The instructors did not rate the experimental group significantly lower than the control group on any task. In fact, the experimental subjects performed better on all five tasks that produced significant group differences in proficiency ratings. In addition, the experimental group generally received higher ratings than the control subjects. Students

receiving the additional UH60FS training met ATM standards on 52.9% of their practice iterations compared to 38.2% for the control subjects. In short, if the instructors required subjects in the experimental group to execute more practice iterations in order to improve substandard performance, then they did not reflect this opinion in their ratings of the subjects' performance.

A more plausible interpretation is that additional simulator training allowed the subjects to utilize their subsequent training hours more efficiently. Having already performed many of the procedural and contact flight tasks in the UH60FS, the experimental subjects possibly required less verbal instruction and demonstration in the aircraft and, therefore, were able to complete more practice iterations.

The results of this study indicate that few aviators met or exceeded the criterion for proficiency (two consecutive trials satisfying all ATM standards) on as many as half of the tasks, and that in only one instance (experimental group performing emergency procedures in the flight simulator) did the mean rating for a group meet criterion. In other words, through the last day of training, most of the students from both the experimental and control groups could not perform the required tasks in accordance with ATM standards. As stated in the Flight Training Supplement for the UH-60 AQC (Department of the Army, 1983, p. 1-1), student performance should be considered unsatisfactory when a task is not performed within the limits established by TC 1-138; however, all subjects participating in this study subsequently passed their UH-60 AQC end-of-course checkrides within two days of the last day of training.

Six additional hours of flight simulator training devoted to contact skills provided the opportunity for students to complete more practice iterations on most tasks in both the aircraft and simulator; however, there were no systematic differences in the level of proficiency related to this additional training. Furthermore, most of the subjects performed below ATM standards through the last day of training. The increased number of practice iterations completed by the

experimental group is seen as a beneficial effect of extended training in the UH60FS. Furthermore, it is important to note that the data from this study produced no indication that additional simulator training impaired the students' progress in any way.

PROJECT STATUS

All data have been collected and analyzed. The first draft of the final report was submitted to ARI in August 1984.

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A PLAN OF RESEARCH TO ASSESS THE APPLICATIONS AND BENEFITS OF THE AH-1 FLIGHT SIMULATOR FOR TRAINING FIELD-UNIT AVIATORS

Dr. Kenneth D. Cross, Project Director,
Dr. Dennis H. Jones, and Dr. George L. Kaempf

BACKGROUND

The Army's Synthetic Flight Training System (SFTS) has been audited by the Army Audit Agency (AAA) on two occasions: first in 1981 and again in 1984. The results of the first audit are described in AAA Audit Report SO 82-6, (U.S. Army Audit Agency, 1982); the results of the second audit are summarized in a letter from the Southern Region U.S. AAA to the Assistant Secretary of the Army for Research, Development, and Acquisition (27 August 1984).

The overriding issue in both audit reports was the number of flight simulators that are required to support the training of field-unit aviators. Specifically, the AAA concluded that the unit-training requirement can be met with fewer flight simulators than are specified in the Army's Basis of Issue Plans (BOIPs). In their audit reports, the AAA has strongly emphasized that both the BOIP and the AAA analyses of flight simulator requirements are based on only the most vague information about the roles that flight simulators are to play in unit training. As a consequence, the AAA has strongly urged the Army to undertake the research needed to quantify the return on the Army's investment in flight simulators that are to be used solely to train field-unit aviators.[1]

It is generally recognized that five factors must be considered in assessing the return on the investment in flight simulators:

- the cost of acquiring, housing, operating, and maintaining the flight simulators;
- the cost of transporting unit aviators to the flight simulator;
- the number of aviators to be trained in the flight simulator;

[1] The return on investment in flight simulators used for institutional training was not questioned by AAA and, therefore, is not among the issues addressed in this research plan.

- the amount of flight simulator training each aviator will receive; and
- the benefits of the flight simulator training.

Information on the first three factors is available or can easily be obtained. However, little information is available on the last two factors: the amount of flight simulator training unit aviators should receive, and the benefits of the flight simulator training. It is these two factors that are the primary concern of this research. Specifically, the research has been designed to generate data with which to specify the type and amount of training that unit aviators should receive in flight simulators, and, to the extent possible, quantify the benefits of this training.

Early in the research planning process, it was concluded that initial research efforts should focus on a single flight simulator, and that the AH1FS is more suitable for this research than any other flight simulator now fielded (UH1FS and CH47FS) or soon to be fielded (UH60FS). The reasons for focusing on a single flight simulator are twofold. First, conducting research on two or more simulators concurrently would require more research personnel than can easily be mustered. Second, conducting research on two or more flight simulators concurrently would result in unnecessary duplication of effort. That is, it is believed that much of what is learned from the initial research on the AH1FS can be generalized to any other rotary-wing flight simulator that is to be used for unit training.

Factors considered in selecting the single most suitable flight simulator include: the number of unit aviators available to participate in the research, the number of simulators available at field-unit locations, and the range of tasks that are potentially trainable in the flight simulator. On all three counts, the AH1FS was judged more suitable than the UH1FS, the CH47FS, or the UH60FS.

RESEARCH PLAN

This section describes the plan of research that has been designed to provide data with which to assess the benefits and limitations of employing flight simulators to train field-unit aviators. Although this research was designed specifically to evaluate the AH1FS, the general approach is considered suitable for assessing the unit-training benefits and limitations of any Army flight simulator.

The task-flow diagram in Figure 1 shows the research tasks to be accomplished and shows the interrelationship among the tasks. Each of the tasks shown in Figure 1 is discussed below in the order in which they are to be accomplished.

Conduct Analytical Studies

This project will commence with two analytical studies. The product of the first study will be a training-task taxonomy; the product of the second study will be a listing of target training tasks and conditions.

Develop training-task taxonomy. An essential first step in this research is the development of a comprehensive training-task taxonomy. An acceptable taxonomy must list the full set of flying tasks that AH-1 aviators must be capable of performing, and the full range of conditions in which aviators must be capable of performing each task. The Aircrew Training Manual (ATM) task list represents a good point of departure, but cannot be used in its present form for two reasons. First, the ATM tasks differ greatly in their level of specificity; some tasks, such as Hovering Turn, are very specific; other tasks, such as Navigation by Dead Reckoning, are very general. Second, the ATM tasks are not mutually exclusive; that is, some ATM tasks are composites of several other ATM tasks.

The final product will be a task-by-condition matrix that shows, for each task, the conditions under which an AH-1 aviator may be required to perform that task. The training task taxonomy will be

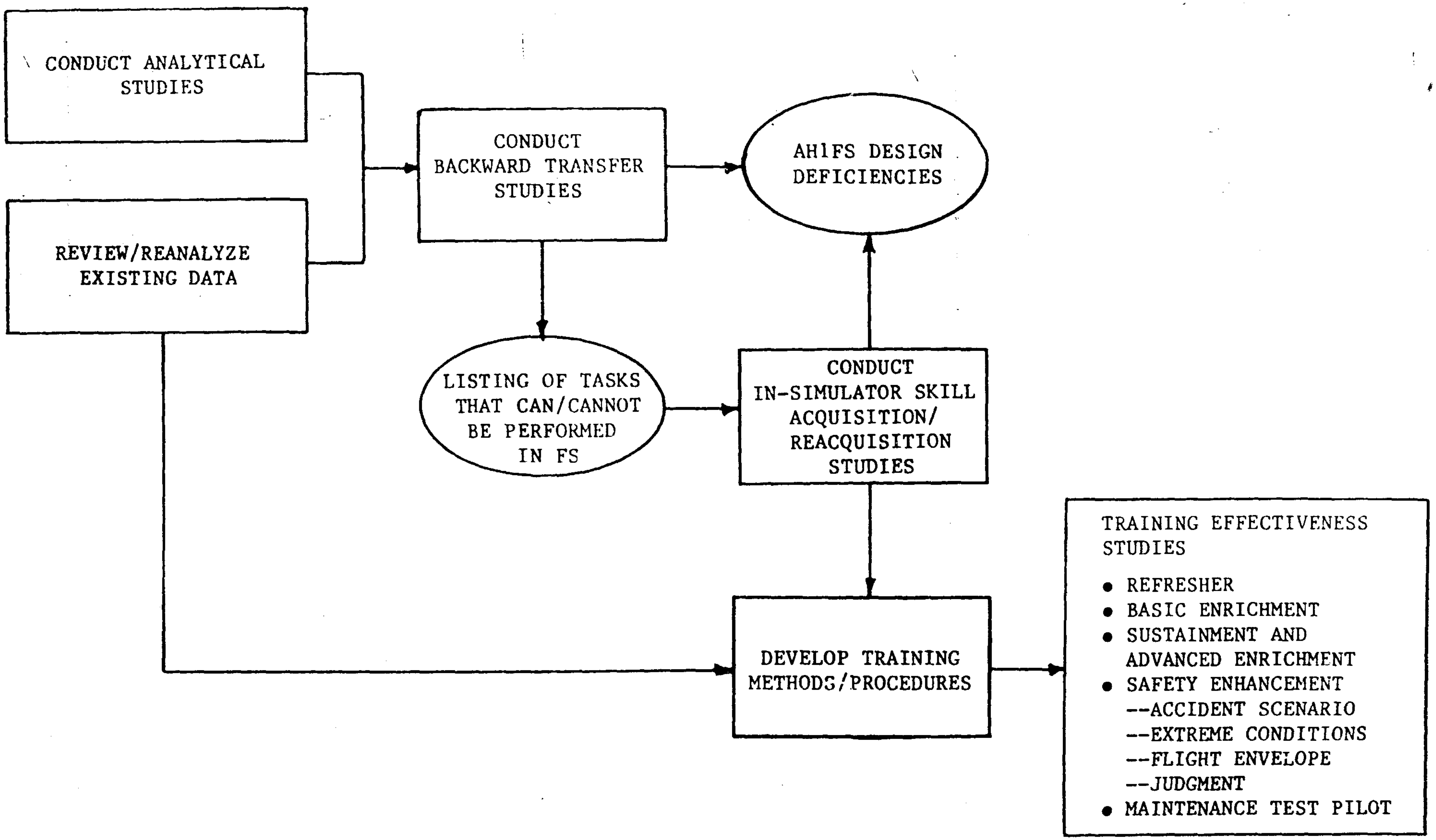

Figure 1. Task-flow diagram for simulator research plan.

developed and evaluated by knowledgeable aviators and training experts. The training task taxonomy will be continuously refined until it is possible to define any training scenario by linking together task/condition combinations represented by cells in the matrix.

Identify target training tasks/conditions. The purpose of this analytical effort is to examine each cell in the task/condition matrix, and to identify the tasks/conditions for which flight simulator training is possible and probably beneficial. A thorough study of the design characteristics of the AH-1 flight simulator will be required to determine whether or not it is possible to simulate a given task/condition. When it is clear that a task/condition combination cannot be simulated, an attempt will be made to determine whether or not a low-cost design modification would make it possible to simulate the task/condition in question. If so, the simulator design modification will be recommended. If not, the task/condition will be eliminated from further consideration.

Each of the task/condition combinations that remain in the matrix will then be examined and a judgment made as to whether or not benefits would result from training that task in the AH-1 flight simulator. This analytic judgment will be made with respect to three target groups: aviators who require refresher training, low-time unit aviators, and medium- and high-time unit aviators.

The most critical and most difficult part of this effort will be to judge whether or not an adequate level of skill on a given task/condition can be acquired and sustained during routine mission-support flying. Obviously, simulator training makes no sense if aviators can easily acquire and sustain skill on a task during routine mission-support flying. In order to make such judgments, it will be necessary to conduct structured interviews with selected field-unit aviators and, possibly, selected DES personnel as well.

The tasks/conditions remaining in the matrix constitute the target tasks/conditions that are to be investigated during the empirical research.

Before proceeding, it should be stated that judgments about whether simulator training is possible and beneficial will be conservative. That is, no task/condition will be eliminated from the matrix if there is any chance that simulator training on that task/condition would be possible and beneficial.

Review/Reanalyze Existing Data

The objectives of this analytical effort are (a) to review and, when necessary, reanalyze existing data bearing on the use and benefits of flight simulator training, and (b) use the composite data to draw inferences about the design of the empirical research to be conducted subsequently. Because of its complexity, this analytical effort is described in a separate document that will accompany this research plan.

Conduct Backward Transfer Studies

Research requirement. A "backward transfer study" is one that is designed to measure the degree to which actual flying skills transfer to a flight simulator. Only highly experienced aviators are used as subjects in a backward transfer study. The procedure is simple: an experienced aviator is placed in the flight simulator and instructed to perform the task of interest without the benefit of practice. If the aviator is able to perform the task to criterion, backward transfer is said to have occurred. The presence of backward transfer indicates that transfer from the flight simulator to the aircraft will be positive, but provides no information with which to estimate the magnitude of the positive transfer.

More important for purposes of this research is the lack of a high degree of backward transfer. The inability of experienced aviators to perform a task to criterion in the flight simulator must be taken as evidence of a problem with either the design or the functioning of the flight simulator. Hence, the absence of a high degree of backward transfer signals the need for further study of the flight simulator's characteristics to determine the reasons for the low backward transfer.

It is essential that such problems be resolved before proceeding to the more costly training effectiveness studies.

A variation of the backward transfer study is to train the experienced aviators in the simulator until their performance reaches an asymptotic level. This variation, of course, is appropriate only when there is a low degree of backward transfer. The nature of the learning curve in such cases provides useful diagnostic information. For instance, if the learning curve asymptotes below the criterion level of performance, it must be concluded that the flight simulator is either not providing the necessary cues or is incapable of processing control inputs correctly. Conversely, if the learning asymptotes at the criterion level after only a few practice trials, it can be concluded that the lack of high backward transfer is probably the result of small differences between the handling qualities of the simulator and the aircraft.

A second variation of the backward transfer study is to interview the subjects a second time after their first aircraft flight following simulator training. These interviews, like the earlier ones, would be aimed at identifying (a) differences between the handling qualities of the simulator and the aircraft, and (b) differences between the cues available in the simulator and the aircraft.

Research objectives. The backward transfer-of-training studies have the following objectives:

- validate the results of the analytic study (can task be performed in the flight simulator?),
- validate simulator functioning,
- identify low-cost simulator design modifications that would increase the degree of backward transfer,
- establish upper limit of performance in the flight simulator, and
- determine the amount of flight simulator-unique learning that is required to perform to criterion level in the simulator.

Conduct In-Simulator Skill Acquisition/Reacquisition Studies

Research requirement. The training effectiveness of any training device is largely determined by the manner in which it is used. This is particularly true for flight simulators. And yet, there is little empirical data that can be used to identify near-optimal training methods and procedures. Hence, before research is conducted to assess the training effectiveness of the AH-1 flight simulator, it is essential that research be conducted to assess the relative effectiveness of alternative training methods and procedures. This research must address the following training-program design issues and perhaps others as well:

- the order in which tasks are trained;
- the amount of training on each task/condition (fixed number of practice iterations vs. training to criterion);
- type of practice (repeated iterations on individual tasks vs. a training scenario);
- training schedule, including duration of flight simulator training and the interval between sustainment/enrichment training sessions;
- the type of feedback provided to the trainee; and
- the use of the instructional support features available on the AH-1 flight simulator.

Research objectives. The objectives of this research are to develop and evaluate the relative effectiveness of alternative training methods for each type of flight simulator training application, including:

- refresher training,
- basic enrichment training,
- advanced sustainment/enrichment training,
- safety enhancement training,
  --accident scenario training,
  --extreme conditions training,
  --flight envelope training,
  --judgment training, and
- maintenance test pilot training.

Develop Training Methods/Procedures

The composite results of the analytical studies, the backward transfer studies, and the in-simulator skill acquisition/reacquisition

studies will be used to develop training methods/procedures for each of the following types of flight simulator training:

- refresher training,
- basic enrichment training,
- sustainment and advanced enrichment training,
- safety enhancement
  --accident scenario training,
  --extreme conditions training,
  --flight envelope training,
  --judgment training, and
- maintenance test pilot training.

The training methods and procedures will be developed by a team composed of experienced AH-1 aviators, psychologists, training technologists, and experts in simulator design.

Evaluate Refresher Training Program

Research requirement. Some portion of a unit commander's annual flight hour program involves using AH-1 aircraft time for refresher training. The Commander's Guide to the Aircrew Training Manual (FC-1-210) defines refresher training as training for aviators "prohibited or excused from flying duties for more than 180 days" (p. 2-34). Anecdotal evidence suggests that between 5 and 15 AH-1 aircraft hours are required to "refresh" the skills of ARL3 aviators. It is possible that a significant portion of the refresher training currently being conducted in the AH-1 aircraft could be trained in the AH1FS. Thus, a requirement exists to determine in what way, and to what extent, the AH1FS can be used to fulfill these refresher training requirements.

Research objective. The objective of this research is to obtain data with which to evaluate the effectiveness of the AH1FS for accomplishing refresher training for ARL3 aviators.

Basic Enrichment Training

Research requirement. As emphasized earlier in this report, increased operational effectiveness is the ultimate criterion for evaluating the utility of the AH1FS for unit training. The assumption has been made that if the AH1FS can be used to increase the proficiency

of the AH-1 aviators assigned to the unit, the AH1FS will have made a major contribution toward increasing operational effectiveness. A second assumption made here is that the training requirements for increasing the proficiency of low time aviators are markedly different from the training requirements for increasing the proficiency of medium- and high-time aviators. Thus, two different training programs--basic enrichment training and sustainment and advanced enrichment training--have been recommended as viable training programs for utilizing the AH1FS at the operational units.

Basic enrichment training focuses on skill enhancement for low-time aviators who have recently completed the AH-1 AQC. The primary goal of basic enrichment training is to decrease the amount of time required to develop the level of skill and confidence needed to assume the responsibilities f PIC. Unit commanders realize that the operational effectiveness of their unit depends, to some extent, on how quickly new aviators can develop and solidify their basic skills and assume mission responsibilities once held by vacating aviators.

Thus, a research requirement exists to evaluate the extent to which basic enrichment training in the AH1FS increases the proficiency and confidence of low-time AH-1 aviators.

Research objective. The objective of this research is to obtain data with which to assess the effectiveness of the AH1FS for increasing the level of flying skills and confidence of low-time AH-1 aviators.

Sustainment and Advanced Enrichment Training

Research Requirement

Experienced aviators require training to ensure that skills to perform relevant flight tasks are maintained and that these skills are not seriously degraded by environmental or situational constraints. In attempting to delineate the types of AH1FS training that would increase the operational readiness of experienced aviators, requirements for two types of training emerged. Each is discussed in detail below.

Sustainment training. First, experienced aviators could benefit from training in the AH1FS on those tasks for which skills are not maintained during routine mission-support flying. Currently, AH-1 aviators are utilizing aircraft time to practice some tasks. Should it be demonstrated that the AH1FS could be used for skill sustainment, valuable aircraft hours could be devoted to other types of training (e.g., ARTEP). It should be noted that there are four categories of tasks for which skills are not maintained during routine mission-support flying:

- tasks that can be trained in the aircraft but are not ordinarily performed during routine mission-support flying,
- tasks that cannot be trained easily in the aircraft (e.g., IMC flight),
- tasks that are not currently being trained in the aircraft (e.g., touchdown emergency maneuvers), and
- tasks that are more effectively trained in the AH1FS (e.g., gunnery tasks).

Taken together, these represent a formidable array of tasks for which skills could decay without sustainment training in the aircraft or the AH1FS.

Advanced skill enrichment training. The second type of AH1FS training that could be beneficial for experienced aviators involves skill enrichment. In the basic enrichment training program discussed earlier, low-time aviators are provided with AH1FS training on all ATM tasks under daytime and nighttime conditions; basic enrichment training focuses on skill solidification, increased competency, and increased confidence for low-time aviators. For experienced aviators, it is possible to concentrate on a very similar task list, but increase the complexity of the tasks by requiring the aviators to perform the tasks under adverse conditions, including the following:

- wearing night vision goggles,
- wearing mission oriented protective posture (MOPP) gear,
- visual obscurants (rain, snow, fog, smoke), and
- wind (gusts, wind sheer).

Anecdotal evidence suggests that concern for safety prevents or severely limits the extent to which aviators are permitted to practice

under these conditions. And yet, military doctrine suggests that, should a military engagement occur, it is highly probable that there would be a requirement to conduct military operations under low illumination levels, adverse weather, and/or in nuclear, biological, or chemical (NBC) conditions. Therefore, this type of enrichment training in flight simulators will clearly have a positive impact on the operational readiness of the units.

For the most part, rotary wing training programs assume that by demonstrating skill proficiency on ATM tasks, the aviator will be effective when required to perform combinations of those tasks under wartime conditions. Although ARTEP training provides the aviator with valuable insight into the battlefield experience, ARTEP training focuses largely on coordination and cooperation among various battle elements. Because of safety constraints, it is difficult, if not impossible, to "load the aviator up" with multiple tasks requiring rapid decision making and effective time-sharing techniques. However, this type of training is feasible using the AH1FS. For this reason, it appears highly desirable to include in advanced enrichment training a set of mission scenarios that are designed to increase aviators' ability to perform effectively during periods of heavy cognitive and perceptual-motor workload.

In addition to the above, advanced enrichment training should include training in air-to-air combat and training in evasive actions for other threat weapons, including air defense weapons and small arms fire.

Taken together, these types of training for experienced aviators, subsumed under sustainment and advanced enrichment training, represent an attempt to formulate an effective training strategy for increasing proficiency and thereby improving the operational effectiveness of the units. Thus, a requirement exists to determine the effectiveness of the AH1FS in accomplishing such training.

Research objectives

The specific objectives of the research on sustainment and advanced enrichment training are to obtain data with which to assess the effectiveness of the AH1FS for each of the following:

- facilitating skill sustainment on those tasks not performed during routine mission flying,
- facilitating skill acquisition and sustainment for a variety of ATM tasks under a variety of adverse conditions (NVG, MOPP gear, visual obscurants, wind),
- increasing proficiency under high workload conditions,
- increasing air-to-air combat proficiency,
- increasing proficiency in performing the full range of evasive actions, and
- increasing aviator judgment ability under a wide range of conditions.

Safety Enhancement Training

This subsection describes research to evaluate the effectiveness of the AH1FS in conducting four different types of safety enhancement training.

Accident Scenario Training

Research requirement. Although some aircraft training is aimed specifically at countering accidents, aircraft training in potential accident-producing situations necessarily involves some risk of causing the very type of accident the training is designed to counter. This risk would be eliminated if Army aviators could acquire the necessary accident avoidance skills in a flight simulator rather than in an aircraft. In addition to risk reduction during training, it is altogether possible that aviators could acquire a higher level of accident avoidance skills in the flight simulator than in an aircraft. In a flight simulator, it is possible to expose the trainee to all events up to and including the crash itself. Such exposure, of course, is not possible in the aircraft.

Accident scenario training is one type of training that promises to reduce the incidence of frequently occurring accident types. As was stated earlier, accident scenario training involves the use of a flight simulator to re-enact, as faithfully as possible, all the conditions and actions that have been shown to contribute (directly or indirectly) to a frequently occurring type of accident.

The accident types to be investigated during this research will be selected with the assistance of personnel from the U. S. Army Safety Center. However, it appears likely that the following accident types will be among the ones selected for study:

- brown-out by blowing dust,
- dynamic roll-over,
- loss of tail rotor effectiveness, and
- settling with power.

Descriptions of the above accident types can be found in TM 55-1520-210-10 and FM 1-51.

Research objective. The objective of this research is to assess the effectiveness of the AH-1 flight simulator for training aviators to avoid and/or recover from known accident-producing situations.

Extreme Conditions Training

Research requirement. Because of a unit commander's concern for safety, most aircraft training is conducted when environmental conditions are optimal or near-optimal. Although aircraft training during adverse environmental conditions would increase aviators' combat capabilities, such training is certain to increase the incidence of accidents during training. It seems reasonable to hypothesize that flight simulator training under adverse conditions would decrease accident likelihood, especially under combat conditions where frequent exposure to adverse conditions is to be expected; there is a requirement to submit this hypothesis to empirical test.

Research objective. The objective of this research is to assess the effectiveness of the AH-1 flight simulator for training aviators to operate the aircraft in extreme environments.

Flight Envelope Training

Research requirement. Safety considerations prevent IPs from exposing trainees to the handling qualities of the helicopter when flying near the extremes of the flight envelope. Consequently, aviators may be unprepared to control the aircraft when the situation requires them to fly at or near the extremes of the helicopter's flight envelope. If true, accident likelihood could be reduced by using the AH1FS to train aviators to operate at or near the limits of the AH-1 aircraft. The reduction in accident likelihood could be of critical importance in combat, where extreme maneuvers may be essential for survival. The intent is to search the accident files of the U.S. Army Safety Center for accidents that have resulted from aviator inability to control the aircraft at the extremes of the flight envelope. This type of accident prevention training would focus on these accidents.

Research objective. The objective of this research is to obtain data with which to evaluate the effectiveness of the AH1FS for training aviators to fly at or near the extremes of the AH-1 flight envelope.

Judgment Training

Research requirement. There is clear evidence that poor judgment is a frequent contributor to both civil and military aircraft accidents (Lindsey, Ricketson, Reeder, & Smith, 1983; Jensen & Benel, 1977), and there is growing evidence that judgment training has the potential for reducing the incidence of such accidents (Berlin et al., 1982; Brecke, 1982; Saleh, Leal, Lucaccini, Gardiner, & Hopf-Weichel, 1978; Jensen & Benel, 1977). Preliminary study indicates that judgment training on some judgment-related accidents could best be conducted in a flight simulator. Hence, there is a requirement to evaluate the potential f : conducting such training in the AH1FS.

Research objective. The objective of this research is to obtain data with which to evaluate the effectiveness of the AH1FS for providing training that reduces potentially accident-producing judgment errors.

Maintenance Test Pilot Training

Research requirement. Maintenance Test Pilots (MTPs) ordinarily become qualified by completing a course of instruction at the United States Army Aviation Logistics School (USAALS). Aviators may also receive MTP qualification by successfully completing an MTP equivalency administered by a USAALS Maintenance Test Flight Evaluator (MTFE). In either case, MTPs must learn to perform a variety of inflight maneuvers to assess the functioning of the aircraft and to correctly diagnose malfunctions when they are present. Like other unit aviators, MTPs have continuation training requirements they must fulfill (see FM 55-44). Many of the maneuvers that MTPs must perform during training and during maintenance check flights are violent and potentially hazardous.

Initial training and continuation training of MTPs is a potentially beneficial application of the AH1FS. However, the benefit of such training will depend upon the extent to which aircraft malfunctions can be programmed and the fidelity of the simulator's response to the programmed malfunctions. Research to assess the benefits of MTP training in the AH1FS will be conducted if the preliminary research shows that a sufficient number of malfunctions can be programmed and the simulator's response to the malfunctions is acceptable.

Research Objective

The objective of this research is to assess the effectiveness of the AH1FS for training MTPs.

ESTIMATED SCHEDULE

The estimated schedule for each of the ten major research activities is shown in Figure 2. The schedule is depicted in months after the official start date for the project, which has not yet been established. In developing the schedule, it has been assumed that there will be no delays in gaining access to an AH1FS or in gaining access to aviators to serve as subjects in the various research activities. It

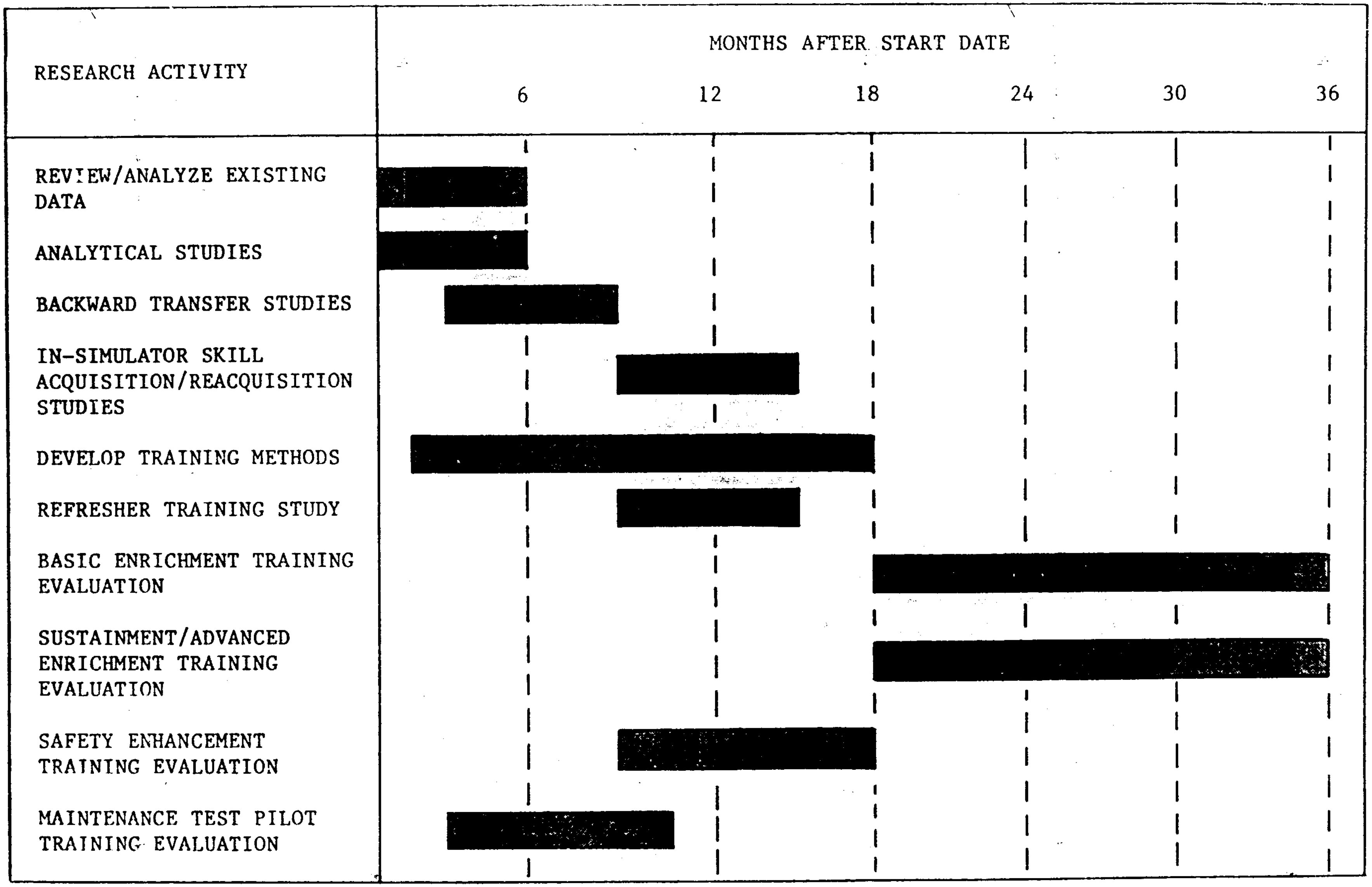

Figure 2. Estimated milestones for major research activities.

also has been assumed that the flight simulator will be available for at least five hours per day during data collection periods.

PROJECT STATUS

Work Completed

This research plan has been submitted to ARI for review. In addition, various agency representatives at the U.S. Army Aviation Center have been briefed about the scope of the research plan. These briefings have been well received and full cooperation in the implementation of this research is expected. Additional briefings to the AAA, as well as various TRADOC and Department of the Army representatives, are expected during the latter part of calendar year 1984. The expected start date for this simulator research project is approximately 2 January 1985.

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